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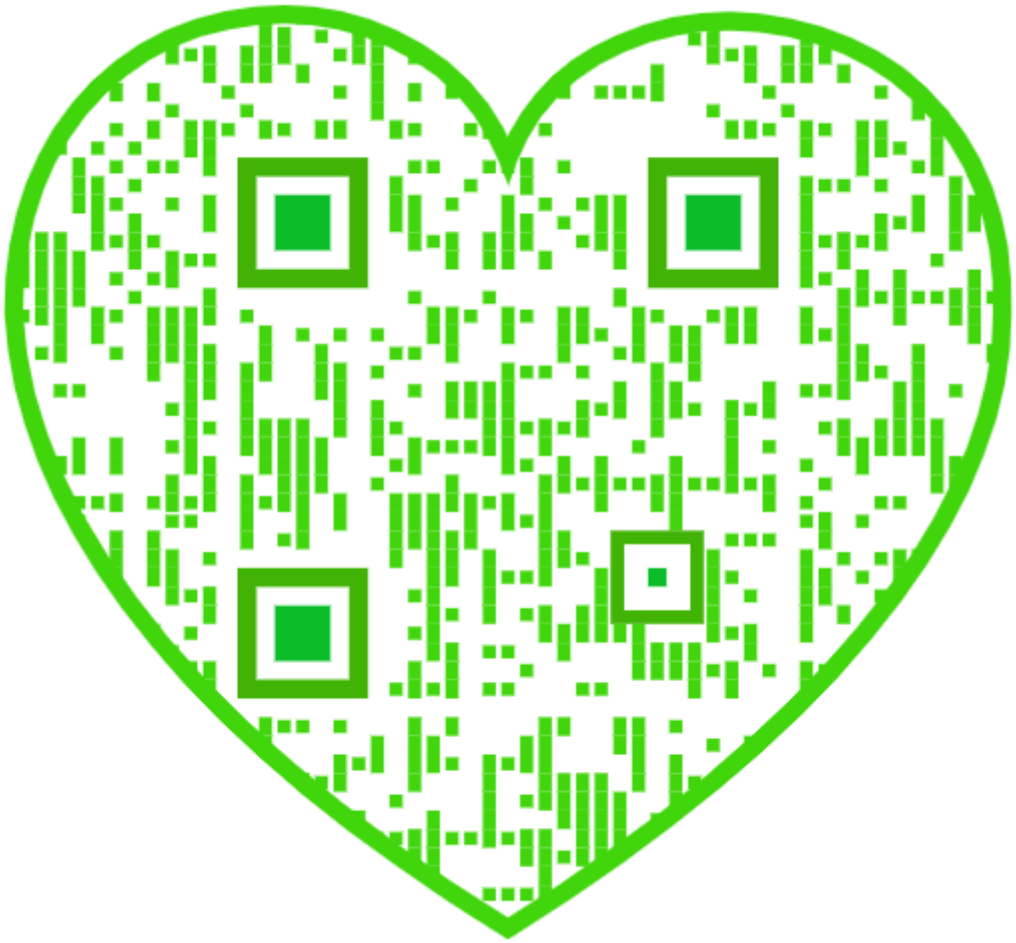

MUNICIPAL ENGINEERING

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JANUARY—JUNE, 1918

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147928
7/1/14

ENGINEERING PUBLISHING COMPANY
INDIANAPOLIS, INDIANA CHICAGO, ILLINOIS

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VOL. LIV.
No. 1.

Municipal Engineering

CHICAGO, ILL.
JANUARY, 1918.

Design, Construction, Operation and Maintenance of all Public Works

Can We Learn From England and France?

Our own Benjamin Franklin said: "Experience keeps a dear school, but fools will learn in no other." The frankest critic hardly will assert that we are not willing to learn from the experience, and profit by the mistakes, of others, but a serious question may fairly be raised as to our ability to learn from others.

At the time the United States entered the war, and the British and French advisory commissions visited this country, Americans congratulated themselves at their good fortune in being told of British and French mistakes so that we could avoid making the same mistakes. Yet we read that many skilled workers, much wanted in industry, were drafted into the National Army as common soldiers. This was one of the best advertised of the British mistakes, one well known at least two years ago to all American citizens who read the newspapers. Still we persisted in making the same mistake.

Are we going to insist on making the same mistakes as England and France in curtailing public improvements? Sometimes it seems so. In those countries improvements were much curtailed on the outbreak of hostilities and there is small wonder, for those unprepared countries were under the necessity of withstanding the sudden and terrific assault of the well-prepared enemy. Here no such emergency existed, yet we are disorganizing industry almost as thoroughly as though the Hun were actually at our gates.

At the beginning of the war, for example, Great Britain concentrated her energies on war work and neglected to continue the work of highway construction and maintenance. The roads soon became so bad that war efforts were seriously crippled, and men were withdrawn from military service and sent home to repair existing roads and build new roads where necessary.

France did not make this particular mistake—the French appreciated the military value of highways from the beginning. They saw no conflict of interests between war work and highway work but perceived that the two activities were inseperable. France has kept a large force of men constantly at work on highway construction and maintenance, not only at the front but throughout the nation. As a result of this wise policy, the French railroads have been relieved of great burdens and much of the ordinary haulage of freight has been handled by motor trucks on the highways.

England curtailed road construction and was wrong, as events proved, and we know it; France increased her road building activities and was right, and we know it. Yet unless Priority Order No. 2 is lifted we will be deliberately choosing the wrong course. England was wrong; France was right. Can we learn from England and France?

English and French cities, too, passed through their period of restricting the construction of public improvements, just as so many American cities are doing today. They have seen their mistake. Can we see it, too, or must we learn by making exactly the same mistake?

Two or three years ago it was when we first read of comprehensive preparations for peace in England and France. The planning of public improvements, to be made during and after the war, is an important part in the preparation for the return of peace with its economic and social problems.

The French Senate recently passed a law compelling every French city to lay out all its future development along modern city planning lines. Since the war began Paris created a city planning bureau with broad powers which has developed comprehensive plans not only for the entire city but for the surrounding area. Other French cities have been equally alert. In Limoges four and five story tenement buildings, covering an area of six acres, were recently torn down at a cost of millions of francs, in order to make way for broader streets and to rebuild the district along modern lines. The city of Marseilles has spent $8,000,000 replacing tenement districts with broad streets, open spaces and modern buildings.

Since the war began London has worked out comprehensive plans and traffic routes for nearly two thousand square miles around the city. In England it is held that the end of the war must see an enormous expansion of building activities and pressure is being brought to bear on public authorities, national and local, to plan and initiate these things now. The British hold that the need for action in development plans is sufficiently great in normal times, and that the abnormal conditions produced by the war have made it even greater.

And what of Belgium? If any nation could be excused for temporizing certainly Belgium is that nation. But the Belgians are forward-looking people who are preparing for peace. The leading Belgians are now preparing plans for great civic improvements and one expert is in this country securing data and information on our normal methods.

Fortunately many Americans are also awake to the desirability of planning and carrying on public improvements at this time. The Chicago Association of Commerce, for example, while giving its energy to whole-hearted support of the war problem, has tried to learn by the experience of our allies in the making of public improvements. Recently the president of that association pointed out that any study of the municipal affairs of the European countries, who have been

through over three years of intensive warfare, will show conclusively that part of the war program has been the planning of large municipal undertakings.

A great readjustment of all business affairs must come at the close of the war and this will cause a serious depression in many lines of business. Many soldiers will return to civil life only to find their old places filled or abolished. Distressing conditions are likely to exist which will call for a wide distribution of charity unless great public works construction programs are all ready to launch.

England and France know these things and are preparing for peace. Can we learn from England and France?

That Word "Municipal"

The word **municipal,** as it is used in the title of this publication, should be broadly interpreted or it is quite misleading. Latterly, usage has tended to restrict the application of this word to the city, whereas pure diction still applies the word not only to the city but to the state, the county and the township. As we use it, it has the latter significance and we desire to place emphasis on that fact.

Those who read the publication carefully can be depended upon to appreciate the breadth of its field. They know that country roads, for example, are regularly treated from the engineering standpoint. The problems of the state and county engineer are given proper attention. With this issue we begin the publication of a drainage and irrigation section. These are not **city** activities, as we shall handle them, but they are **municipal** activities in the sense that they are largely planned by public officials and paid for out of public funds. Since we treat of such projects as are paid for by public funds there is no good reason why exactly similar projects, from the engineering standpoint, paid for by private funds should not also be described in this publication, so the breadth of our field is great.

While on the subject of our title let us emphasize, also, that this is an engineering publication. This is not a civic journal, an uplift organ, or the official organ of ladies auxiliaries of ward improvement associations.

Those who would understand the scope of this publication need do not more than read our subtitle: The Design, Construction, Operation and Maintenance of All Public Works.

A Labor Fallacy

Authorities at Washington are somewhat complacent, admittedly, about throwing some men out of their accustomed employment, because of the fact that men are needed in other lines more directly connected with the prosecution of the war. Apparently it is the assumption that if a man loses one job he will unerringly and speedily secure another in a line considered more essential during the emergency.

While there is undoubtedly a theoretical tendency in the direction the officials seem to have in mind the actual reapplication of labor is difficult and in some cases virtually impossible.

On public works construction in Chicago, for example, the laborers are not young men of the best military age. In fact, the majority of these men are above military age and would not enter the army even if unemployed, moreover, they have grown old in this form of public service and know little else. They would not be efficient on any other kind of work.

To stop public works construction in Chicago would undoubtedly throw out of employment thousands of men who would remain idle until this work was resumed. These men would no more go to the coast cities to work in ship-building or munitions plants than they would go to Mars to extend that planet's irrigation system.

Buy Motor Trucks Now

Contractors and others who are a long time making up their minds whether they want to purchase motor trucks or not, may find, when they finally do decide to buy, that they will have a long wait for deliveries. The demand for trucks is now great and is increasing, so contractors should place their orders now for immediate or spring delivery.

Contractors are not strangers to the hazards of business, and ordinarily are willing to assume risks. It is true there is a reasonable doubt about the volume of work, in some lines, for contractors the coming season, but their is small doubt there will be extensive construction of interstate and intercity hard roads. The contractor can afford to assume that there will be a good volume of road work. The best information obtainable, as well as a study of the European precedents, indicates the raising of the embargo on the shipment of road-making materials and an increasing volume of road construction. Trucks will be used more than ever this season on road construction, so contractors should get in their orders now.

Arthur Brisbane, the able and influential editor, is advocating a short-haul railway embargo, to compel the use of motor trucks on short hauls thereby leaving the railways free to handle long hauls. The arrangement advocated would save shippers much demurrage due to the bad habit of slow unloading of freight cars. Small freight shipments for short hauls tie up freight cars and cut down the efficiency of such cars. Brisbane's suggestion may not be formally adopted officially, but it will very likely be urged officially and voluntarily adopted by shippers. This will greatly increase the demand for trucks.

Motor freight haulage is gaining enthusiastic support on all sides daily. The advantages of such transportation are becoming better understood. There are several motor truck routes in successful operation, and they are being well advertised. With trucks the load goes from point of origin to point of delivery direct, while with rail shipments the load must be handled four times instead of twice. This not only saves transfer charges, but saves time, and relieves railway car shortage and congestion. Some observers say that trucks will soon be employed to haul the bulk of freight shipped short distances, say up to 75 or even 100 miles. Think what a demand this will make for trucks!

The government is purchasing thousands of motor trucks and will doubtless continue a big buyer of trucks as long as the war lasts. All lines of business are motorizing their haulage and delivery departments more rapidly and more extensively than ever before.

For the various reasons enumerated, the demand for trucks is increasing daily, with no let-up in sight, so contractors should place their orders now.

Design and Construction of the Water Purification and Softening Plant at Great Falls, Montana.

By Robert E. McDonnell, of Burns & McDonnell, Consulting Engineers, Interstate Building, Kansas City, Mo.

GREAT FALLS, MONT., with a population of about 30,000, has for years used the Missouri river water in its raw state for both domestic and fire uses. An agitation for a pure water supply has extended over a period of about ten years, the agitation being due to the fact that the water was very turbid at certain seasons of the year and that typhoid cases in the city were also above normal. About two years ago the State Board of Health of Montana took an active interest in the health conditions of the city, believing that much of the typhoid of the city was undoubtedly due to using the Missouri river water without adequate purification.

Women Demanded Soft Water

One bond issue had previously been defeated for the installation of a filtration plant, but the defeat was attributed largely to the fact that information concerning the beneficial results of filtration and the cost of purifying water was not clearly and fully presented to the citizens. To avoid the mistakes made formerly the citizens undertook to inform themselves thoroughly as to the value of pure water, cost of filtration, beneficial results of filtered water, and a campaign of education was conducted largely through the influence of the Commercial Club, Rotary Club, Women's clubs and other civic organizations. At one stage of the discussion it was found that the women voters of the city would be against the bond issue for filtration unless it also included water softening, so to insure the success of the bond issue the plans were therefore made to provide for a combined water softening and purifying plant. Although the water is not an unreasonably hard water, the desirability for a softer water was felt by the women voters.

GENERAL VIEW OF SETTLING BASINS, RAISED MIXING CHAMBER, CHEMICAL HOUSE AND FILTER HOUSE, GREAT FALLS, MONTANA, WATER PURIFYING AND SOFTENING PLANT.

After bonds had been voted for the project, the engineers employed by the city, Burns & McDonnell, Kansas City, Mo., were instructed to prepare their plans and specifications to cover both water softening and purification. A citizens' committee was appointed outside of the City Council to take charge of the execution of the work, and this citizens' committee, which was composed of the leading citizens and several local engineers, passed upon the plans, specifications, receiving of bids, final tests and other details of the entire work.

Design of Plant

The improvements consist of an electrically-operated low-service pumping station, which takes water direct from the Missouri river and discharges it into a mixing chamber, where the chemicals are thoroughly mixed with the water previous to its passing into the settling basins. After passing through the settling basins the water then flows into eight 1,500,000-gal. filter units, thence into the clear water reservoir.

The electrical pumping station equipment consists of four motor-driven centrifugal pumps—two 2,000,000-gal. pumps and two 4,000,000-gal. pumps, or a total of 12,000,000 gal. pumping capacity.

The purification plant consists of, first; a reinforced concrete mixing chamber. Owing to the softening requirements the mixing chamber was designed with a view of a thorough mix and a long travel of the water before passing into the settling basins. To insure the water passing through the mixing chamber and to overcome the loss in friction through baffle walls, the mixing chamber stands at a level about 3 ft. higher than the settling basins. The travel through mixing chamber is 1,160 ft., requiring a time in the mixing chamber of 36 minutes when pumping at the rate of 12,000,000 gal. per day. When pumping at a higher or lower rate the length of travel and velocity through the mixing chamber can be maintained at various rates by changing the baffle walls or cutting out a portion of the mixing chamber. The velocity through the mixing chamber of .77 ft. per second prevents any sediment depositing in the mixing chamber.

Amount of Chemicals Used

The thorough mixing that is given in the mixing chamber accomplishes considerable clarification before the water even reaches the end of the mixing chamber, and it therefore passes into the settling basin with this clarification process well started. The water has a retention period in the settling basins of about 8 hours when filtering at the rate of 12,000,000 gal. per day; the water, therefore, reaches the filters in a well-prepared condition for filtration. An examination of the residue in the bottom of the settling basins does not show any undissolved or unused chemicals, and experiments were conducted for about 30 days to determine the minimum amount of chemicals that could be used to obtain the most efficient results. It was found that from .6 to .7 grains of sulphate of iron was the amount of chemical required for thorough sedimentation during ordinary stages of the water. This quantity will undoubtedly have to be increased during the highest turbidity stages of the water. Although the natural lime in the water is small, yet with the thorough mixing accomplished in the mixing chamber it was found that it was not necessary to add lime to the water, and the omission of lime is a large saving in the annual cost of operation. This saving in lime is undoubtedly accomplished by the thorough mixing the water receives in the mixing chamber.

Chemicals for both water purifying and softening are fed by dry-feed machines, and are connected with a Venturi meter and so arranged that the chemicals fed are in direct proportion to the water used. It is believed that this saves greatly in the amount of chemicals used, as well as in getting a uniform strength of solution.

At Great Falls, as in many other cities, the volume of water pumped during the 24-hour period varies greatly at different portions of the day. The water consumption at Great Falls will vary from 2,000,000 to 12,000,000 gal. per day, and the dry-feed machines automatically control the chemicals, thus having the proper amount of chemicals for the water used.

The chemicals for the plant are purchased in carload lots and hoisted by electric elevator to the fourth floor of the chemical house, where the chemicals are placed on top of concrete hoppers which lead to the hopper of the dry-feed machines on the floor below.

The Filters

The filters are arranged in eight units, four on each side of the main filter floor, partially exposed so that the water can be observed. The filter units are of 1,500,000-gal. capacity each, and cleaning is accomplished through the use of air and water and all valves used for cleaning and controlling are electrically operated. The operating tables are of marble construction. The loss of head gages, sampling devices, clock and all equipment is of nickel-plated finish. The loss of head gages are of the recording type, which both indicate and record the loss of head consumed in the operation of the filter and indicate the time when the filter requires washing. Each loss of head gage is equipped with three indicating pointers, the first indicating the water level in the filter, the second indicating the wash water pressure, and the third indicating the loss of head in the filter. The recording chart is rectilinear in form, graduated horizontally in hours and vertically in feet, and so arranged that each will give record for 24-hour run of the filter. The rate of filtration in each filter is controlled by an outlet

EXTERIOR VIEW REINFORCED CONCRETE LOW SERVICE PUMP STATION, GREAT FALLS, MONTANA, WATER PURIFYING AND SOFTENING PLANT.

controller in the effluent pipe. By means of a graduated hand-wheel located on the operating floor the rate controllers may be set to give any desired rate of filtration between the limits of zero and 2,000,000 gal. per day for each filter.

Filter Plant Accessories

The pipe gallery beneath the main filter floor is well lighted and has sufficient space and head room to make it easily accessible for observation or repairs.

The motor-driven air blower has a capacity of 2,600 cu. ft. of free air per minute at 4 lbs. pressure, and is operated by a 50-h.p. squirrel cage electric motor. The blower is of the Root type and has a capacity and pressure sufficient to give a uniform agitation of sand by the air.

A part of the equipment is a 24-in. Venturi meter recording the rate of flow in gallons per day, with a chart recorder giving an unbroken autographic record of the rate of flow from hour to hour, and a counter-dial showing the total gallons of water that have passed through the meter. These features, while not absolutely essential in any water works plant, are considered desirable for an efficient and intelligent operation of any modern water works plant.

Removal of Bacteria

The guaranteed bacterial efficiency of 97 per cent. was exceeded considerably in the tests which were conducted for about 30 days, the filtered water being clear and sparkling and free from suspended matter, odors, turbidity and discoloration. In a series of tests the bacterial efficiency for each filter was as follows:

Raw water from river	1,480	bacteria	per c.c.
Water in settling basins	910	"	"
Water from Filter No. 1	8	"	"
Water from Filter No. 2	14	"	"
Water from Filter No. 3	6	"	"
Water from Filter No. 4	6	"	"
Water from Filter No. 5	4	"	"
Water from Filter No. 6	8	"	"
Water from Filter No, 7	2	"	"
Water from Filter No. 8	8	"	"
Average of the eight filters	7	"	"

Efficiency of filters, or average bacteria removal from water, 99.52 per cent.

Efficiency of settling basins, or bacteria removal from settling basins alone, 38.5 per cent.

No liquid chlorine was used in this test.

In Filter No. 2, which shows 14 bacteria per c.c., this sample of water was collected immediately after washing Filter No. 2.

Chlorination

The entire plant is provided with liquid chlorine equipment as an adjunct to the filter plant, but not as a substitute for filtration, for it is a well-recognized fact that liquid chlorine does not make a dirty water clean, and it should be used as a sterilizer for emergency purposes rather than depended upon as a means of purification.

One noticeable result since the plant has been placed in operation is the decline in the sale of bottled water, for analyses have shown that the municipal supply is far superior to most of the bottled, including spring and distilled, waters on the market.

Settling Basins and Clear Water Reservoir

The settling basins are 18 ft. deep, 160 ft. wide and 180 ft. long, having reinforced concrete slab covers. The floors consist of two layers of concrete with waterproofing between the joints. Two reinforced concrete 6-in. baffle walls extend the full length of the basins. The basins are divided into two chambers, so that when one is undergoing cleaning or repairs the other may be used. The mixing chamber is also divided into two chambers, so that one half may be used while the other is being cleaned or repaired. The outside of the settling basin is of the buttress type, reinforced, but with the excavated earth filled to the top of the basins.

Beneath the filter house is the clear water reservoir, also of reinforced concrete construction. This has a depth of 9 ft., and the water flows from this clear water reservoir by gravity to the suction of the high-duty pumps. The location of the plant on a hillside gives 12 ft. head to the suction of the high-duty pumps. All the piping from the pump station to the purification plant passes through a 6-ft. by 8-ft. reinforced concrete tunnel under the Great Northern Railroad tracks.

Filter Buildings, Etc.

The filter house, chemical house and head house are of brick construction, using buff-colored pressed brick exterior, with steel roof trusses, and large windows of the "Fenestra" sash type. Considerable ornamentation was given to the exterior and interior of the filter house building, with the idea in view that the plant will be visited and inspected not only by the citizens of Great Falls, but by many representatives of other municipalities.

Inspecting the Plant

It is taken for granted that the average layman is not thoroughly familiar with the process used in water purifying and softening, and it is believed that better results in cities can be accomplished by making the water users familiar with the care with which their water is treated and handled. Inspections of the plant are invited. During the first month's operation of the plant at Great Falls representatives from about

fifty municipalities inspected the plant and its operation, and it is believed that such inspections greatly aid in the general education of the public to realize the value of pure water and how it can be obtained.

A complete softening of the water is not attempted, as the water is not an unusually hard water, but a partial softening is accomplished at reasonable expense, the soda ash for softening being also fed by a dry-feed machine and into the mixing chamber along with the sulphate of iron and lime.

It is believed that the installation at Great Falls embodies all of the modern features of water softening and purifying plants to make it not only efficient in results, but economical in operation.

Meterage Follows Filtration

Great Falls, like many Western and Northwestern cities, has used water at flat rates, but with the installation of the purification plant it is realized that it is poor business policy to filter water for irrigating use for parks, lawns and war gardens; therefore, the officials are taking the preliminary steps toward placing all water users on a meter basis. The water

INTERIOR OF LOW SERVICE PUMP STATION, GREAT FALLS, MONTANA, WATER PURIFYING AND SOFTENING PLANT.

consumption at Great Falls at the present time is reported to be highest of any city in the United States, being approximately 400 gal. per capita per day. The use of meters was not considered while raw and highly turbid water was being used, but now, with a clear, sparkling water, no objection can be urged against the use of meters.

The entire grounds surrounding the filtration plant, consisting of about ten acres, is being beautified by the Park Board by building of roads, paths, lawns and shrubbery, as well as ornamental lighting, in the belief that efforts to supply good, clear, pure water should be supplemented by making the building and grounds equally clean and attractive.

With the installation of meters it is believed that the present water purifying and softening plant is sufficient to take care of a population of approximately 100,000.

A new 48-in. flow line to the suction of the pumps is now being installed and other improvements in reinforcing the distribution system are in progress. The entire distribution system in the city is of cast iron and consists of about forty-five miles of pipe. The water is delivered into the mains under direct pressure by five motor-driven high-service centrifugal pumps.

The above work was let by competitive bidding and was subdivided into three sections. The total cost, including engineering, real estate and incidentals, was approximately $225,000.

Personnel

Olson & Johnson, of Missoula, Mont., were the contractors who installed the settling basins, filter house and the general construction work. The low-service pump installation, including all piping, was installed by the Merkle Machinery Company, and consisted of Platt Iron Works pumps and General Electric Company meters. The water softening and purifying plant was installed by the Pittsburgh Filter Manufacturing Company, of Pittsburgh, Pa. M. L. Morris, who supervised the installation of the work, has been appointed by the city as superintendent of filtration, and has full charge of the operation of the plant. The plans, specifications, supervision of construction and final tests were conducted by Burns & McDonnell, consulting engineers, Interstate Building, Kansas City, Missouri.

Procedure in the Maintenance of Automatic Sewage Siphons and Ejectors

Apparatus usually receives, at the hands of the designer, considerable thought and study in standard construction and standard uses; also, in special uses a further amount of study is required to adapt standard equipment to the purposes intended. Such study and research varies in direct proportion to the personal equation of the manufacturer. It can be stated, however, as quite a matter of fact, that no apparatus is offered for sale or installation for any unsuitable use, if the manufacturer is fully advised in advance.

It is obvious, therefore, that all parties contemplating the use of automatic equipment, such as sewage disposal apparatus, ejectors, etc., should avail themselves not only of the literature the manufacturer prints, but the personal services of the same manufacturer in an advisory capacity, before such equipment is ordered through the contractor.

Precautions in Design and Installation

In designing plants requiring apparatus, full consideration should be given for growth in volumes of sewage to be handled and the character of the sewage, in order that the apparatus may be adequate in size to perform the duty required, and in many instances, particularly in ejectors, duplicate installations, each equal to the maximum requirement, should be installed.

In installing apparatus of this character the municipalities should employ the manufacturer to exercise a certain amount of supervision, as may be required, to see that the work is performed in such a manner that the apparatus will satisfactorily operate and continue to operate.

The municipalities should require full sets of assembly drawings of all such apparatus, and, before the contractor is discharged and the apparatus accepted, the mechanic to be placed in charge of the plant should be carefully instructed in the use of the apparatus.

Specific Suggestions on Maintenance

In the maintenance of such plants the municipalities are under the disadvantage of frequently changing their employes, and it must be obvious that an unskilled operater may not be able to secure from any apparatus the results obtained by his predecessor, who was able to operate the plant and understood thoroughly the basic principles of the machinery.

A record should be kept at the plant of the performance of the apparatus, the same requiring little or no attention, except possibly after a very heavy storm in plants where the sewer systems tributary are combined and not separate.

All moving parts apparatus requires considerable attention at the place of wear, and non-moving apparatus requires occasional cleaning.

Pits and pockets containing apparatus are likely to sludge up, and should be pumped out and kept clean at the bottom, at comparatively regular intervals.

Plants should be more or less protected from loose leaves, sticks, and rubbish generally, which may be thrown into the pits, and this is accomplished by covers over the apparatus, with open joints for ventilation.

Plants that are exposed to freezing in very cold exposures should be protected during the winter months.

It would be wise for each municipality to employ the original designing engineer to inspect its plant at intervals of, say, once in sixty days for large plants, and possibly once in six months for smaller plants. The expense for such inspection would be well justified, as errors in operation would be corrected and results obtained continuously for which the plant was originally designed.

The manufacturer of the apparatus furnished and installed could properly be employed in the larger plants to make examinations, rather than to permit an unskilled operator to conduct his own experiments, or to alter the apparatus without consulting the manufacturer.

In a general way the simpler the apparatus is, the more readily it is comprehended by the average caretaker, and the more reliable the manufacturer is, the more serviceable the apparatus will be.

Summary

In summarizing, it would appear to be very essential that maximum volumetric conditions be thoroughly taken care of in the original design; that loss of head necessary for successful operation be also thoroughly understood and arranged for; and, further, that the apparatus itself be observed at regular intervals, and all chambers containing the same be protected from rubbish of all sorts, and frost, and kept clean, so that the equipment may not fail.

All hydraulic apparatus requires to be installed in watertight compartments, and the outfalls from the plant must be able to take off the sewage at the maximum rate, and the outlets remain free at every point.

Municipalities owning sewage disposal plants should not hesitate to communicate with the manufacturers of all such apparatus, providing themselves with proper assembly drawings and literature pertaining to the special apparatus furnished, and its engineering department should be familiar with these also.

Imperative Need of the Lakes to the Gulf Deep Waterway

By H. B. Morgan, General Manager, Peoria Water Works Co., Peoria, Ill.

We have to the north of us a chain of lakes with more than 4,600 miles of shore. We have to the south of us the Father of Waters, the Mississippi River, which, together with its tributaries comprises more than 16,000 miles of navigable waterways. There never has been a waterway improvement in all the history of the world where the possibilities were as great or where the results, when finished, will be of greater advantage to as great a number of people, as to connect the Great Lakes with the Mississippi and the Gulf of Mexico, said Mr. Morgan in addressing the Illinois Section of the American Water Works Association.

Compared with Suez and Panama Canals

The Suez canal was a wonderful undertaking, and has been productive of great good. The construction of the Panama Canal—the wonder of the world——was a stupendous task that cost millions upon millions of dollars, and it is bound to be of great benefit to the water transportation of the world. Both of these canals put together are not of as great importance to the people of this country and to the people of the world, which we must help to feed, as connecting the Great Lakes with the Mississippi River and the improvement of all its tributaries.

Right here, I ask you to stop and consider what it would mean to this country at this time of war preparation, and the heavy, urgent demand for food and other supplies for our soldier boys at the front and in the camp, as well as for the soldiers of our allies, if this chain of Lakes and these magnificent rivers were connected with adequate waterways.

Illinois River a Fine Stream.

Did you know that, for its length, the Illinois River is the peer of any river in this country, if not in the world? The channel rarely ever changes. The pilot who "ran the stream" a quarter of a century ago would have no difficulty in taking a boat from La Salle to Grafton, although he may not have been over the stream in the meantime. At least, this is the testimony of the old time pilots themselves.

The distance, by river, from La Salle to Grafton is about 230 miles, with an average declivity of only 1½ ins. to the mile. The stream today has a minimum depth of 7 ft. and to make it a deep waterway it would only be necessary to dredge soft mud from its bottom, and remove the two state dams and the two Government dams. Since the opening of the Chicago Drainage Canal, with a portion of the waters of Lake Michigan flowing down this way, these dams are an obstruction rather than a benefit to navigation.

Need of Lakes to Gulf Waterway Long Recognized

For almost two and a half centuries, ever since Joliet and Marquette, in 1673, crossed the divide from the Des Plaines River to Lake Michigan, on their return from the Mississippi River to Green Bay, the need of a waterway through the divide has been felt.

In 1819, the St. Louis Enquirer said: "The communication between Lake Michigan and the Illinois River is a point which will fix the attention of the merchant and the statesman. They will see in it the gate which will open the northern seas into the valley of the Mississippi, and which is to connect New York and New Orleans by a water line which the combined navies of the world cannot shut off. Never did the work of nature require so little from the hand of art to complete so great a design."

For years and years the question of a better and bigger canal from the lakes to the Illinois River, one that would accommodate modern steam propelled craft, has been agitated. And since the opening of the Chicago sanitary drainage canal, the need of the improvement has been felt more than ever before.

The Mississippi Below Cairo

By far, the biggest problem to be solved, in constructing a deep waterway from the Lakes to the Gulf is that portion of the Mississippi River below Cairo. There the channel of the River is ever changing, owing to the wash of the banks, which are made up of soft alluvial earth. It has been estimated, that the amount of sediment carried down the Mississippi and emptied into the Gulf of Mexico every year is almost, if not quite equal to a cubic mile.

For upwards of 60 years, the General Government has been striving to find some way by which the channel may be controlled, and millions upon millions of dollars have been expended in experimenting along these lines, with little, if any, permanent benefit.

Let us hope that some way will be found to solve the problem, and that a great waterway will eventually be constructed down there, to the end that boats of large tonnage may pass unobstructed from the gulf to the lakes.

When this result is accomplished we of the Mississippi and Illinois valley will be able to transport freight from and to the Pacific coast in competition with New York and other Atlantic coast points.

Cheapness of Water Transportation.

In the past Peoria has shipped certain class freight by rail

to the Atlantic Coast, there transfer it to ships which took it through the Panama Canal, up the western coast to San Francisco and other points on the western coast, for a less rate than could be had by all rail route to the same points. The all water rate from New York to San Francisco is about half of the all rail rate from Chicago and Peoria, to the same place.

How long do you think we can stand this and remain on the map commercially?

When we stop and consider that 24 ft. of water can be had from the Gulf of Mexico to the Gulf of St. Lawrence, a distance of 3,300 miles, for less than the cost of the Panama Canal, and that the value of the Panama Canal to this country is a mere bagatelle when compared to the 24 ft. waterway, then it is that we wonder why our government has not long ago developed this waterway.

Comparison of Water and Rail Rates.

Several years ago Major Riche of the Army Engineer Corps, in a report to the War Department, supplied the following figures, as a comparison between the rates from St. Louis to St. Paul, 573 miles by rail, 729 miles by river, and the rates from St. Louis to Oklahoma City, 543 miles by rail, with no water competition:

Rail rate to St. Paul, first class	.63
River rate to St. Paul, first class	.40
Rail rate to Oklahoma City, first class	1.30

The rail rate to Oklahoma City, with no water competition, for virtually the same distance, is approximately twice that along the route where there is water competition.

Major Riche then goes on to say: "While it is not claimed that river improvements are solely responsible for the great difference in freight rates above shown, it is well known that where ever water competition exists, whether by river, canal or lake, its effect on freight rates is always beneficial to the public, and so long as the navigation is practicable, and somewhat in proportion to the feasibility of that navigation, such benefits will accrue even if but little river commerce is actually carried on."

Conclusion.

Failure to improve our waterways will work disaster, not only to cities in the interior, but to those on the coast as well. The prosperity of port cities, and of the railways by which they are served, depends upon the prosperity of the territory tributary thereto.

Our waterways are of vital importance to our national interests, whether in time of peace or in time of war, and nothing whatever should be allowed to prevent or delay their improvement.

Commercial supremacy is based upon industrial development; industrial development depends upon economy of transportation, and the cheapest of all transportation is water transportation.

PAVEMENT DESIGN AND CONSTRUCTION

Asphaltic Macadam Road Building in the Michigan Copper Range

By C. C. Lakin, 72 W. Adams St., Chicago, Ill.

Houghton county, Michigan, in the heart of the copper country, has many miles of good roads and is adding more each year. The Dollar Bay road, built during 1917, is typical of construction methods used on most all of their roads.

The Houghton County Commission do most of the work with their own organization under the direction of Mr. Randolph Martin, County Engineer, and his assistant Mr. Thomas Coons.

The stone used in road building is crushed with their own equipment from tailing piles from the copper mines, and delivered to the different locations in the county over railroads, and is in most cases dumped in bins from which wagons are loaded with little labor.

Following is a description of the methods, followed in constructing the Dollar Bay Road:

Grading

The roadway was graded to a width of 16 ft. and cut and fill made to bring the sub grade to 7½ ins. below and parallel to the finished surface of the pavement. The crown was carried at 2½ to 3 ins., a 3 ft. shoulder was made on each side of the roadway, drainage ditches excavated at both sides of road and culverts built across the roadway where necessary. As the roadway was brought to grade it was thoroughly rolled with a 10-ton roller.

Base Stone

The base stone, ranging in sizes from 4 in. to 2½ ins. was then spread on the prepared roadway, at the rate of 6 sq. yds. to the cubic yd. This stone was then thoroughly rolled with a 10-ton roller. On this was then spread screenings and chips at the rate of 25 sq. yds to the cubic yard, and thoroughly rolled. It was then ready for the 2½ in. pouring course stone.

Key Stone

The key stone and top dressing chips were delivered at the side of road as the placing and completion of the base or foundation progressed, being deposited in certain sized piles, certain distances apart as called for, to secure a uniform spreading of 60 and 70 sq. yds. to the cubic yard, respectively.

Pouring Course

The stone used in pouring course was graded from 2½ to 1¼ ins. and was dumped and strung on the roadway about 3 ft. from the side at the rate of 16 sq. yds. to the cubic yard, hauling 2 cu. yds. to the load. A 4-wheeled 2-horse road grader was used to spread the stone over the roadway. This was accomplished to a fairly uniform thickness and was brought to perfect grade by a little hand trimming by men with rakes and shovels. The course was then rolled with a 10-ton roller, going over the surface twice, care being taken not to pack or crush stone by excessive rolling. After the rolling, the surface was gone over and any low places raised with more stone and tight or close places loosened up to permit of free penetration of the asphalt. The course was then ready for the asphalt.

Application of Asphalt

The Stanolind Paving Asphalt was applied at a temperature of 300°F, under 45 lbs. pressure. The tank wagon used was furnished by the Standard Oil Company being equipped with a compressor, large fire box, and all the necessary appurtenances for the unloading from tank cars, as well as applying it on the road. On the Dollar Bay road the tank wagon was hauled to and from the tank car, a distance from the work of about one mile, by four horses.

When the tank wagon reached the work it was pulled

over the roadway by the steam roller which also furnished the steam to run the air compressor attached to the tank. The first application of asphalt was made at the rate of 1½ gals. to the square yard. The spreading of the ⅞ to ½ in. key stone followed, and was uniformly spread at the rate of 60 sq. yds. to a cubic yard.

When the tank was emptied it was turned around and pulled back over the key stone to where the road was completed, and taken back to the tank car by horses. The roller then thoroughly rolled the key stone course and any excessive amount of key stone was broomed off.

The next tank load completed the above portion by the application of ½ gal. Stanolind Paving Asphalt to the square yard, and also continued applying the 1½ gal. application on the first or pouring course ahead.

VIEWS ON THE CONSTRUCTION OF THE ASPHALTIC MACADAM DOLLAR BAY ROAD, HOUGHTON COUNTY, MICH. Top Row (Left to Right): Subgrade made and Shoulder Constructed, Roadway Ready for Foundation Stone—Placing Base Stone at Rate of 6 Sq. Yds. to 1 Cu. Yd.—Base Stone Rolled and Ready for Fine Stone Filler. Bottom Row: Filler Stone Spread and Rolled in Base Stone; Pouring Stone strung Along Sides to be Spread with Road Grader—Application of Stanolind Paving Asphalt to Pouring Stones at Rate of 1½ Gals. to Square Yard—Completed Roadway Opened and Used as Fast as Top Dressing was Spread and Rolled.

The one-half gallon application was followed as closely as possible by the spreading of the top dressing stone chips ranging in size from ⅝ to ¼ in. free from dust and spread at the rate of about 70 sq. yds to a cubic yard. This was thoroughly rolled and opened to traffic as fast as finished.

Quantities

Each day's work was brought to as nearly a completed condition as possible. The work progressed at the rate of about 730 ft. or 1,300 sq. yds of completed road each day.

The completed pavement averaged 8 ins. thick and required about 790 lbs. of stone, and 2 gals. Stanolind Paving Asphalt "C" to the square yard, making the average weight of the pavement 807 lbs. to the square yard or about 100 lbs. to each inch in depth to the square yard.

The accompanying photographs show the different stages of the work from the grading to the finished roadway.

Using Stone Crushing Outfits to Utilize Street and Road By-products

In New England many of the municipalities and leading contractors are installing stone-crushing outfits to utilize by-products of the streets and roads, such as brick, cobble stone, broken concrete, worn out curbing, and paving blocks, and find that the practice pays. One day recently a dozen Mayors, representing as many Connecticut Cities, met by appointment in Meridian, Conn., to witness a practical demonstration of a gasoline driven machine combining the functions of a street sprinkler, sweeper and dust gatherer. The machine did perfect work at the speed of 18 miles per hour. Several municipalities in New England, notably Worcester and North Adams, Mass., are puting their crushing plants into their gravel banks and running all raw materials into the crusher.

Basic Principles of Design, Construction, Maintenance and Financing of Roads and Pavements

By J. W. Howard, C. E., E. M. Consulting and Testing Engineer of Roads and Pavements, New York City.

It is wise for city, county, state officials and engineers connected with making plans and specifications for roads and pavements and supervising their construction and maintenance, as well as the public which uses them and pays their cost, to remember certain basic principles which are essential for the construction of good and efficient roads and pavements, and their continuous economic maintenance in good viable condition thereafter.

All roads and pavements, which are finally economic, in regard to the cost of first construction together with the subsequent, eventual necessary maintenance in proper, constant good condition for many years and indefinitely, consist of three distinct parts:

Three Parts of a Road

First—A Subsoil, well drained and firmly consolidated.

Second—A Foundation or permanent base of portland cement concrete or of any well established other durable material, such as firm telford; thick consolidated macadam; old worn but solid brick, stone or other blocks properly evened up with a dense water proof asphalt concrete (called "close binder") and thus remade into good foundations.

Third—A Wearing Surface Layer of substantial thickness, to be reasonably durable and designed to enable it to be eventually maintained in constant good condition at the lowest possible annual cost; there being no permanent roads and pavements because all must be constantly maintained.

Pavement Economics

The various materials for foundations have their proper places as well as those for wearing surface layers such as, sheet asphalt, asphalt-concretes of various types, bricks, stone and other blocks, bitumen and water bound macadams, etc.; depending upon local conditions, climate and traffic to be expected, flat or undulating grades, kinds of adjacent property, uses of the road or pavement, etc.; also upon available ma-

terials of construction and the cost of materials and labor. The cost of street cleaning must be kept in mind; also the cost of traction by horse and motor over different kinds of surfaces; and the ease and speed of traffic and beauty of the surface. All are inter-related with the cost of first construction and interest upon it and the cost of continuous maintenance. Periodic repairs are to be avoided, but if made they are a part of maintenance. Constant maintenance is cheapest and best on the principle that "a stitch in time saves nine" and enables a road or pavement constantly to fulfill its proper function of facilitating transportation of light and heavy loads of persons and goods, agreeably, rapidly, safely and economically as modern requirements demand.

Maintenance Most Important

It is well to be guided by the long established policy of the *Ponts et Chaussees* (Bridges and Roads) Department of France, whose Engineers have charge of all roads of France and pavements of its cities, that "Economic, constant maintenance and not low first cost is the truest economy for bridges, roads and pavements." This is because maintenance, including, at long intervals, general repairing or resurfacing, must be paid for from current public direct or indirect taxes, continues for ever, and therefore constitutes the real cost to the people. Maintenance in time becomes a much greater total cost than the first cost of any kind of road or pavement which includes its subsoil preparation, foundation and surface layer. Maintenance is applied generally only to the surface layer; the subsoil preparation and foundation being a permanent investment and should need no maintenance. The types of wearing surface layers which can be repaired and maintained by small additions at short intervals are generally in the end cheaper than the types which must have the entire surface layers replaced at short or even long intervals. Types of wearing surface layers which can be constantly repaired, do not obstruct traffic when prompt repairs are made to worn or injured spots or areas.

Financing

The problems of financing, constructing and maintaining roads and pavements are closely interdependent and require the services of properly qualified experienced engineers. These matters should not be undertaken by the legislative and administrative officials nor by laymen and citizens, without reliable expert engineers, any more than the matters of sanitary sewers, water supply systems and other public works.

The original capital from bonds or assessments, invested in the three stated parts which constitute the whole road or pavement from bottom to top, will always be on hand, provided current good maintenance is paid from current income. This current income comes from taxes, automobile and other sources benefitted by good roads and pavements; which means from almost every body, because transportation serves all of us.

The many millions spent in the past and more than $400,000,000 now being spent annually for new roads and pavements in the U. S., makes the problem of economic maintenance the vital one. Without economical, good maintenance we will lose many millions of investment and many roads and pavements now built and be unable to add much more mileage to that we now have.

Drainage, subsoil preparation, foundations and wearing surface layers of roads and pavements are each separate important subjects which must be carefully studied. Each is a subject upon which much information exists and many separate useful articles can be written.

Reinforcement for Concrete Pavements

In the search for the ideal pavement practically all the materials of construction have been tried. While concrete has been used for years as the base or foundation for pavements, having some sort of brick, block or asphaltic wearing surface, it is only within a comparatively short time that this material has been used throughout in the construction of roads and street pavements.

UPPER—CURING CONCRETE PAVEMENT BY PONDING, BELLEVUE AVE., HAMMONTON, N. J.
MIDDLE—SETTING KAHN ARMOR PLATE IN PROPER POSITION BY USE OF INSTALLING DEVICE.
LOWER—VIEW ON BALTIMORE PIKE, A 22-MILE CONCRETE ROAD, NEAR WAWA, PA.

Recent years, however, have shown that the all-concrete pavement laid in either one or two courses gives very satisfactory results. The enormous growth in the yardage of concrete roads and pavements laid during 1915 and 1916 is directly traceable to the fact that concrete pavements have at last come to be considered as one of the reliable standard pavements and not a cheap, makeshift temporary surfacing. With this change in viewpoint has come better engineering;

better and more careful study of local conditions; more carefully drawn specifications, and last, and most important of all, the more careful and conscientious contractor.

Early Concrete Roads

The history of the concrete pavement previous to 1906 is practically a story of occasional effort on the part of more or less daring individuals to make concrete, an important part of all other standard pavements, become the complete pavement in itself. One interesting example of an experimental concrete pavement to which reference is now being continually made is that at Bellefontaine, Ohio. In 1893 and 1894 the streets surrounding the Court House in that city were paved with concrete at a rather high cost compared with present day prices; and after over 20 years' wear, the pavements are in a remarkably good condition. It was not, however, until four or five years afterwards that much further attention was given to concrete pavements, when Richmond, Indiana, became the next municipality to experiment with them. Today in Richmond one can see some of the very best examples of concrete alley and street paving to be found anywhere in the country, although in a limited amount.

Undoubtedly the reason why concrete pavements until recent years had not become a factor in the paving industry was largely due to the fact that there had been a lack of concerted action on the part of those most interested in the product. It was not until the cement industries and a few large contracting companies devoted themselves to the concrete paving problem that any direct commercial attention was paid to the product.

Reinforcing Steel

Today we have specifications of the most demanding nature for these pavements—the mixture of concrete, the depth, the protection, and reinforcement are important features.

Reinforcing steel is used throughout the better grade of pavements; and it is of interest to note that in Highland Park, Michigan, 40% of the total paving for one year was of reinforced concrete, costing 68%, or approximately two-thirds as much as other types of pavements. It is hardly necessary to state that Highland Park is now using reinforced concrete for pavements in a steadily increasing amount. St. Clair Heights, Michigan, paved during 1913 a total of 15 streets, of which one is not paved with concrete, 14,000 yds. costing $1.92 per yd. The remainder, or 14 streets totaling 61,000 sq. yds. are all of concrete, costing an average of $1.27 per sq. yd. Therefore 82% of all the paving in St. Clair Heights during 1913 was of concrete costing 66% as much as a competing type.

It has been proven in many localities that concrete pavements are comparatively low in cost, inexpensive to maintain, free from dirt, easy for traffic for vehicles of all description and easily drained.

Such pavements should and are usually reinforced with steel, which overcomes the effects of natural expansion and contraction due to seasonal changes of temperature, provides for the contraction of concrete in setting, prevents cracks caused by any inequalities in the sub-soil and prevents the pulling apart of the pavement from the effect of heavy tracking loads coming upon the outer edge of the pavement at a time when the soil underneath that edge is saturated.

Mesh and Plates

A well established reinforcement, manufactured by a cold-drawn process from one-piece metal plates, has been put forth in Kahn Road Mesh, furnished in flat sheets, obviating the annoyance of unrolling coils, cutting to length and fastening in place in the roadway. It is generally used with Armor Plates. These constitute a late and improved method of protection for expansion joints. It has been proven that practically all transverse cracking in concrete roads can be prevented by spacing transverse joints at intervals of 25 to 30 ft. in non-reinforced payments and from 45 to 50 ft. in reinforced pavements. The better results seem to be obtained from a reinforced slab with spacing of expansion joints 45 to 50 ft. The advantages of these plates, including accurate crowning, positive anchorage, etc., have made them popular for this purpose. They are manufactured of soft, open-hearth steel of just the right composition to absorb the heavy shocks and to wear down with the pavement. Plates are 2½ in. deep and are curved to pitch or crown of pavement.

The installation of these plates is quickly and easily accomplished by the use of the improved installing device which is made for this purpose. Specifications for concrete roads of the present day include Steel Armor Plates in many cases.

Curbs.

Concrete curbs properly constructed are a feature of city streets which should not be neglected. They are popular because of their durability and neat appearance. By protecting the upper outside corner of a concrete curb with a satisfactory steel plate the curb becomes superior in appearance and more wear resisting than even the hardest granite curbs. To this end many municipalities have adopted the use of the Kahn curb bar, which has been found to protect and reinforce concrete curbs very satisfactorily. They are also adapted for curved curbs at street intersections, and provide an ample width and thickness of plate exposed to wear.

Three Representative Concrete Roads

The upper view in the accompanying illustration shows the method of ponding in order to cure concrete properly on Bellevue Ave., Hammonton, N. J. The street is 28 ft. wide, 6 in. thick at the sides and 8 in. at the center. The mixture was 1:2:3, and the pavement was built in 1917. The joints are spaced every 30 ft. the edges being protected with Kahn armor plates. The pavement is reinforced with Kahn road mesh No. 25. Remington & Vosbury of Camden, N, J. were the engineers and Michael Staub, of Mamqroneck, N. Y., the contractor.

The middle view is a construction scene on the Easton Allentown road which was built by force account in 1915 by the Pennsylvania State Highway Department. The view shows a Kahn Armor plate being set in proper position by use of the installing device. Attention is called to the fact that the pavement can be readily finished beneath the device, thus insuring an even and uniform surface. The No. 25 road mesh was also used on this job.

The lower view was taken on Baltimore Pike, near Wawa, Pa. This road was built in 1916-17, on State Highway Route 131. It is 22 miles long and extends from Wawa, Pa., to the Maryland State line at Nottingham, Pa. It is 16 ft. wide, 5 in. thick at the sides and 7-in. at the center. The proportions are 1:2:3. The entire road is reinforced with No. 25 Kahn Road mesh, and the section shown was built by Dwyer & Co., of Philadelphia, Pa., under the supervision of the State Highway Department, Wm. D. Uhler, State Highway Engineer.

Construction Plant and Methods Employed in Building South Meridian Monolithic Brick Road, Indianapolis, Ind.

By Maurice B. Greenough, Highway Engineer, Engineers Building, Cleveland, Ohio

The use of mechanical equipment for surfacing the green concrete foundation and grouting the brick as demonstrated in the construction of South Meridian Road, Indianapolis, Ind., represents a distinct step in advance in building monolithic brick pavements. Moreover, machinery made possible a reduction in man-power, an advantage never more timely than now.

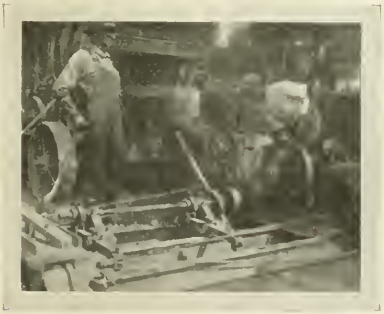
Supporting Template.

South Meridian road is an important artery of Indianap-

olls. The paving recently built begins at the city limits and extends about one-half a mile southward through the township. The total width of the street is about 40 ft; 16 ft. on either side was paved, and the balance left for a single street car track. In the manner of supporting the template the work represented a composite of city street and country road practice. Concrete curbing was provided at the outside edges of the street furnishing the support and guide for one end of the template. Adjacent to the street car tracks, steel side forms answered this purpose. The forms were held in position by steel pins spaced 10 ft. apart. The overhanging edge of the forms fitted into a slotted plate attached to the top of each pin, thus holding the forms true to line and grade. A longitudinal expansion cushion was laid along the curb, equal in depth to the combined depths of brick and concrete.

The Template.

The mechanical tamping template used in consolidating, striking off and smoothing the green concrete base performed all these operations simultaneously as well as drawing itself forward. There were three cutting and smoothing edges provided. Two were rigidly framed, while the third was attached to a rocker arm, driven by an eccentric, which gave vertical tamping motion of about ¼ in. The rocker arm raised and lowered the forward and rear I-beams which served to cut off the concrete and uniformly compacted and smoothed it for receiving the brick. Additional smoothness was gained from the middle I-beam rigidly held in the frame work.



THE MECHANICAL TAMPING TEMPLATE CUTS OFF THE CONCRETE AND TAMPS IT TO UNIFORM DENSITY AND SMOOTH SURFACE. NOTE THE ROCKER-ARM WHICH TRANSMITS THE TAMPING MOTION. THE TEMPLATE IS DRAWN FORWARD BY THE WIRE ROPE WINDING ON THE DRUM

BRICK LAYING AND CONCRETE MIXING 25 FT. APART.

A SMOOTH SURFACE IS PREPARED FOR LAYING BRICK.

BRICK LAID AND ROLLED, READY FOR GROUTING WITHIN 25 FT. OF MIXER.

WIDE TIRES AND EASILY PORTABLE, WITHOUT DISTURBING THE BRICK SURFACE.

No Hand Finishing Required.

Power was supplied by a 6 h. p. gasoline motor mounted in the center of the rigidly framed members of the template. In addition to actuating the rocker arm, the engine drove a winding drum upon which coiled a wire rope, whose ends were firmly anchored some distance in advance of the template, thus securing propulsion. It only remained to lay the brick immediately after the passage of the template. So smoothly was the surface prepared that no supplemental finishing by hand was required. There was absent in the work at Indianapolis any evidence of misconception of what is sought in monolithic construction, sometimes shown by leaving long stretches of green base exposed with the brick unlaid. As fast as the template had prepared the surface the brick were laid, and all the operations of building the pavement were compassed within a distance of 40 ft. Sweeping and rolling immediately followed the brick laying.

Grouting.

The pavement was grouted with a mechanical mixer. The exact amount of water required was measured in buckets for each batch, thereby insuring uniformity in consistency. The effectiveness of mechanical grouting has already been demonstrated; however, the character of the mix and the dispatch with which the grouting proceeded at Indianapolis furnished further evidence of the desirability of the method.

The paving was done under the direction of Mr. Charles Chaney, County Engineer of Marion County, by the Cunningham Construction Company.

Design and Construction of Concrete Roads in Wood County, W. Va.

By Burdette Woodyard, County Road Engineer, Parkersburg, Wood County, W. Va.

Wood County, West Virginia, has adopted concrete as the standard type of county road construction. We are building our roads 14 ft. wide, 7 ins. thick on the center and 6 ins. on the sides, with 3 ft. berm on either side.

Line and Grade.

The slopes and grades are determined by local conditions. It is thought advisable to spend considerable money in grading rather than to exceed an eight per cent grade. With concrete on this maximum grade we have never had any complaints as to slipperyness. The old road bed is followed wherever possible. Where a portion of the concrete is to be laid over a newly made fill it is rolled to a uniform density, soft spots or spongy places are removed and replaced with suitable material. As the drainage of the road bed is of vital importance it has been found wise road insurance to provide French drains or tile drains wherever needed in the sub-grade. While the fact should not be taken as an excuse for neglect in the preparation of the subgrade, it is nevertheless true that a concrete road slab will bridge over numerous defects of soft spots in the subgrade and no serious results will follow. From our experience we have found that much importance attaches to the destruction and scarrifying of the old road bed in order to have a subgrade of uniform density, under the new road. It has been frequently observed that when we had a soft spongy subgrade and expected cracks in our slabs not a single crack has appeared. What few cracks have developed in our roads have been in slabs partly overlaying the former solidly compacted earth road bed, said Mr. Woodyard in addressing the Southern Appalachian Good Roads Association.

Concrete Materials.

For aggregates we use washed and screened Ohio River sand pebbles. These come to the job separately by team or auto truck and are mixed with cement in the approximate proportions of 1:2:4. The voids in these aggregates run approximately constant and it is, therefore possible to secure a remarkably uniform quality of a concrete. The various ingredients are measured separately in such a way as to insure the proper proportions at all times.

Mixing and Placing Concrete.

The materials are mixed in a batch mixer until the cement is uniformally distributed and the concrete is uniform in color. Only enough water is used to produce a concrete that can be spread into position with a template or straight edge. The amount of water used is not sufficient to cause a separation of coarse aggregates from the mortar and depends somewhat on the water content of the sand. Definite specifications on this point are difficult to observe. Continued experience coupled with a desire for high quality of work will usually provide the best guide. After mixing, the concrete is deposited rapidly upon the subgrade which has been sprinkled, to prevent absorption of water from the concrete. A strikeboard is used to give the surface of the pavement the proper contour and

TYPICAL VIEWS OF CONCRETE ROADS IN WOOD COUNTY, W. VA.

the finishing is done by hand with wood floats operated from a bridge resting on the forms. No one is allowed on the concrete after it has been worked into position until it has thoroughly hardened.

Much publicity is now being given the roller method of finishing as inaugurated by Captain J. J. Gaillard of Macon, Georgia. Uniformly excellent results and low cost are claimed for this method by those who are using it. It is possible that Wood county may see fit to adopt this method if results obtained elsewhere continue to support its use.

Curing Concrete.

Extreme care is always used in curing the green concrete. In hot summer weather canvas is placed on the new surface and kept wet for several days to prevent too rapid drying out. Following this the pavement is covered with several inches of earth and kept moist by sprinkling for a week or more. Where the grade of the road will permit, earth dams are built on the surface and the ponding method is used.

Concrete is weakest when it is new. From tests made both in the laboratory and in the field it has been demonstrated that during the first five years of its life concrete is constantly increasing in strength and in ability to resist the wear of traffic. Our experience has been that the longer traffic can be kept from a new piece of concrete the better it will be for the road and the possibility of its acquiring those qualities of hardness and toughness which are characteristic of this type of road when properly built. Our roads are not opened to traffic in less than two weeks. This period is extended if no serious inconvenience is occasioned by a further delay to traffic.

Joints.

It has been our practice to install at intervals of from twenty-five to fifty feet metal protected joints of the bituminous fiber matrix type. The tendency of our present practice is to lengthen the interval between joints. On long slabs over newly made, heavy fills where there is a possibility of further settlement, the joints are omitted altogether. Our theory here being that if cracks should occur the inter-locking effect of the coarse aggregate will prevent any relative motion of adjacent slabs and thus preserve a smooth riding surface.

Up to the present time reinforcing has not been extensively used, although the question is now being considered as to the advisability of omitting the joints and putting the money thus saved into reinforcing.

Wood county has found that by using good clean materials, careful and painstaking workmanship, followed up with proper curing, it is possible to secure a concrete pavement that is practically indestructible. The wearing qualities of these roads are indicated by the fact that on some of them now going into their sixth year of service, the finish marks of the wooden float are still clearly to be seen. Concrete roads built five years ago have never had a penny spent on surface maintenance. The maintenance has been built into roads.

WATER WORKS MAINTENANCE AND OPERATION

Practical Measures for Securing Greatest Economy in Public Utility Plant Operation

I.

By Charles Brossmann, Consulting Engineer, Indianapolis, Ind.

(This is the first in a series of six articles by Mr. Brossmann, giving specific recommendations on measures available for increasing the efficiency of public utility power plant operation, with special reference to the power plant end of the public water works system. This is a neglected and imperfectly understood phase of water works operation and in these times of high costs is supremely important.—Editor.)

How much efficiency will my Pumping Plant or Utility Plant give is asked by the Operator?

This question is similar to the City Man's inquiry of the Farmer asking, "How much milk does your cow give?" "She don't give none," said the farmer, "you have to take it from her by force." Your Power Plant whether it be a water, lighting, heating or whatever kind it be will only give efficiency when you make it do so.

One hesitates to write an article on Efficiency in the Pumpling or Power Plant as the word efficiency has been somewhat abused; more so, however, in industrial than in utility plants. In some industrial plants so much red tape and system has been devised that it has become a burden and the cumbersome records have only been good as items of statistical interest. This has not been so true in the utility plant for the reason that usually it has not been realized that conditions could be improved, and the operators have been content to go along as they have been accustomed to as long as the plant seemed to operate smoothly and satisfactory service was given.

Inefficient Use of Coal

According to the Director of the Bureau of Mines, last year alone, at least one-half a billion dollars was wasted throughout the country by inefficient use of coal. Of 600,000,000 tons of coal mined in the United States last year, the Director of Mines states that we wasted 150,000,000 tons through inefficient use. It can readily be seen that if it were possible to get the utmost efficiency from the thousands of steam users and power plants in this country that the coal situation would be greatly improved over present conditions.

Coal Situation is Acute

Since the war started, the coal situation has developed into an acute question and much more thought is now being given to the question of economy where formerly it was lightly passed by. It is not altogether a case of paying the extra price for coal but it is a case of getting the coal at all.

England has already established a Coal Mines Department, and fuel directors have been appointed in this country. So that the men who formerly did not worry about how inefficiently he operated will now have to look this question squarely in the face.

Small Plants Most at Fault

The larger plants of the country and of course many of the small or medium size plants obtain good economy of operation but the greatest chance for saving is in the hundreds of small plants. As a general rule the large plants are not so susceptible for improvement in power plant efficiency as the smaller plant, as the coal cost percentage is greater in the smaller plant.

Roughly speaking for comparison one may say that a 2,000 H. P. plant would convert 12% to 13% of the heat energy of the fuel into power. Whereas if you take a small plant, say of a few hundred H. P., only about 3 to 4% of the coal energy is developed into mechanical energy. These figures of course are approximate estimates but they show why the small plant must be very much improved to gain the economy practiced in large stations.

Where the same plant is properly operated and where conditions are very favorable quite a high degree of efficiency can be obtained, but every small item must be watched and the many little wastes that creep into power plant operation must be kept at the minimum.

Time to Get Down to Facts.

Right now is the very time to get down to the facts and ask yourself: "What is my Plant doing and what can I do to better conditions?"

The Marathon runner does not start off at once with a great spurt but distributes his efforts throughout the entire course. Study his methods and apply them to the operation of your plant. Get at the question of power plant operation systematically and eliminate inaccuracy and adopt definite and accurate methods. Cut out all waste and even if it does seem small you will be surprised at the results. Those who have already done this, I have no doubt, look back with pride at what they have accomplished. If your plant needs economic changes in operation or installation, it cannot be done in a day. The matter must be carefully studied and viewed from every angle.

Firemen Must Be Encouraged

Recently, I watched a fireman who would fill both sides of the grate under the boilers shoveling in about twenty scoops of coal. He would then sit down or go away and not come back

for 20 minutes. I started him off firing under one side at a time and putting in only a few scoops of coal. After two hours work he seemed inclined to get discouraged as he thought that he could not notice any improvement. He had been firing his way for several years and he did not like to change. He learned how to do his firing from the man ahead of him, and of course, it was not his business and neither could you expect him to think in terms of C. O. 2 or excess air or other unheard of things. This only goes to show that innovations or new methods are hard on some men. The fireman must be encouraged and explanations made and reasons given to get him in line and this is one of your first tasks.

This dirty old boiler room (but I apologize if yours is clean) is the place where you can pay the biggest dividends in your plant. I do not mean to slight the other places; but the constant stream of Black Nuggets flowing through your boiler room represents the work of perhaps millions of years that Old Sol, and the other forces of nature untiringly gave to us. You, of course, are not responsible for all of the loss in the coal but it is the little 1, 2 and 3% losses that, when added together become large, should be taken care of.

Some day a great wizard will probably devise a new method of utilizing the energy of fuel, but this should not make you forget that under present conditions at our very best we cannot help but be wasteful.

Save at the Coal Pile

It was not so many years ago that Indiana was a great gas field and many times I have seen ordinary steam pumps taken and the pressure of gas passed through the steam cylinder as a motive power. Gas was wasted in every conceivable way and today Indiana is dead as a gas field. Therefore, I say, save all along the line but above all at your coal pile which is the foundation on which to practice economy.

The man who wheels in and fires the coal is the one to start on. There is an art in wheeling in and shoveling a barrow of coal, as one fireman remarked to a newcomer. "Drop that wheel barrow; what do you know about machinery?" And if you don't believe this let a fireman from a small saw-mill plant try to fire a locomotive.

Now the preventable waste of coal in this country runs into astonishing figures, even in many large plants as well as the small ones. Try to realize what this means in some big industrial plant using say 20,000 to 30,000 tons of coal a year where the boiler efficiency might be raised 10%.

Lame Excuses

Your boiler plant may only be giving an efficiency of 50% or even less. This is nothing uncommon. But what is your excuse? Ignorance of conditions? That is no excuse. The fact that you as superintendent leave this to your engineer—or that you are running with as little coal as some other plant or a multitude of other reasons do not let you out. You have no instruments or no proper forms to keep records. Well these are easily obtained. A few dollars will start you off and if the powers that be will not pay for them and buy you more and raise your salary when you have produced good results, at least you have made a showing and have some new valuable knowledge which will help you along to better things when the opportunity to change comes.

"Freely give that you freely receive." It will be more than paid back in the end.

Ignorance of Costs

Here is a plant, a public utility, which argues that rates should be raised for this particular service, yet in their yearly report to the State Commissioner, they state "We cannot give the amount of coal per unit of power used." How do they know they are entitled to a raise if they cannot diagnose their operating costs? Many utilities pump not only water but generate light, heat and power and some even manufacture ice, yet do not know what each branch of service is costing them except in the most crude way.

I admire the Theosophist and have respect for his belief. His religion is pure and gentle. He does not jamb it down your throat or force it on you. But it is no religion for the saving of coal. I think the Coal User needs more drastic measures—he needs a little jolt to wake him up because coal has been so plentiful and easy to get that many have become careless and wasteful.

Poor Measures of Efficiency

Some men who run their plants state, "I know our boilers are operating efficiently. I can tell by the color of the fire."—(Can he see the color of the air leaking and seeping through the boiler walls?) Another tells me: "I can tell by the coal pile that we are operating economically." That is wonderful second sight, and without striking a balance sheet between the coal used and power made.

Can you imagine a big department store keeping in business that featured many bargain sales and not knowing what each department was paying! They know just what they are making and losing or they could not continue in business—neither could any big modern concern as a general rule unless they knew.

Know and Study Results.

Every bank strikes a balance sheet each day and at the close of the business day they know just what has come in and exactly what has gone out. But how many power plants know at the end of the day how much coal was burned and how many pounds of steam were made from that coal, and how many gallons of water were pumped with the steam or how many Kilowatts generated? And even if this is known have the results of such a balance been scrutinized and shown anything? If you have the proper records, have you given them the thought they merit? Are the results of water evaporated per pound of coal up to what they should be for your type of boiler and load? Is your feed water hot enough, or are draft conditions in the boiler the best for that day? Do you know whether the boiler is sooted up or tube passages filled with ash? Is the coal to blame or is it some other reason and if so what are these circumstances and how shall they be determined and remedied?

Are you sure that even if your boilers are operating with economy that your steam driven units are in the proper shape? And all steam lines tight and drains and traps without leakage? Has your pump or engine had an indicator on it in the past six months? If not how do you know the valves are tight or set properly?

Must Economize Coal

All of these are perhaps small matters and your plant is only one of a multitude but do not forget that present conditions of production in every line are unusual and the resources of power plants throughout the country are being taxed to the utmost. You are only one of a great team and you should bear in mind the necessity of getting every available heat unit from the coal, every ounce of work from the steam and then deliver your product as economically as possible and with minimum waste.

Do not forget that the mines are not delivering all the coal that we need, that we require more than the mines are usually producing and that the demand is steadily increasing.

How is such a shortage of coal to be taken care of and supplied? In some cases by structural alterations such as new and more efficient machinery, but this is not possible in many cases.

If the coal output cannot be increased then to produce the power the needed results can only be obtained by rigid economy.

Conditions Call for Remedy

The conditions call for prompt and immediate results and

this is entirely possible if strict and intelligent management is practiced. When one considers the vast amount of coal used it is safe to say what hundreds of thousands of tons can be saved annually if every one will do his part. No trouble shall be found in making a saving in the country's fuel of from 10 to 20%. But it means work and constant vigilance and proper co-operation on the part of all parties concerned.

Where shall this start—shall it be compulsory by the Government? This may not seem to be democratic and no doubt would be strongly objected to at least until it were shown to be of advantage in a financial way.

One other way is open and that is on an educational basis, but before any educational system can be a success coal users must place themselves in a receptive mood and have the desire and willingness to work toward such an end, otherwise it will be a failure.

Instruct Operators

It will require tact, study and application. Any system of teaching must not be complex or confusing as the greater part of the saving must be made by the men actually operating the plant. This therefore, calls for direct and simple methods that will be readily understood and easily executed.

The start, of course, must come through the owner, manager or superintendent and thereon down through the chief engineer and down to the firemen. The last being just as important, if not more so, than the owner or manager, as a poor or unwilling fireman, if he tries can, as a rule, shovel more dollars to oblivion than any other agency. A good fireman can make a wonderful difference in the cost of operation.

Therefore, let the first step be educational and in such form and terms as to be readily understood by those who are most responsible. The chief engineer or superintendent can place his instructions and recommendations in such shape that the fireman can understand them and go at it in such a way as to arouse his interest, if possible, for the saving of greater amounts will lie in the hands of these men. Start with them and the small things, such as the heat units (B. T. U.'s), and your total will soon be something worth while.

The Slacker B. T. U.

Behold the nimble B. T. U.
Now hastens toward the lofty flue,
He dances from the coal so black
Around, across and up his track.
Along the furnace fiery walls
He dives and jumps, but never crawls;
Elusive, he, and small in size,
He's never seen by human eyes
But hastening through the sooty tubes
In countless numbers—moves and moves
On through the baffles up and down
Against the shell so smooth and round,
Pushing and crowding here and there
And mingling with the excess air,
Some holding back, a select few
Exclusive with the C. O. 2,
To do their bit and turn to steam
The seething water hot and clean.
But all the rest now rushing go
On through thhe breeching to and fro,
Rushing in haste to reach the stack
A crowd of Slackers, a lazy pack,
Up through the stack and to the air,
On, on they go; Do we despair?
Ten thousand strong to every pound,
The work of Ages in the ground,
Now and forever more they're lost
Into the great unknown they've crossed.
Quick! Plaster the Brick work, close the cracks,
Change the draft, and raise the stack,
Level the fires, shovel the coal
A scoop at a time if you'd reach your goal,
Or the nimble heedless B. T. U.
Will prove much more than a match for you.

The Dual System of Water Supply Recommended for Eastern Cities

By Robert J. Thomas, Superintendent of Water Works, Lowell, Mass.

What is the ultimate solution of the problem of supplying water to cities situated in more or less congested centers of population, such as those found in the eastern section of the country and especially in eastern Massachusetts?

Increasing Supply Is Difficult in East

Many of these cities have no available sources of supply large enough to meet their constantly growing needs, and the prospect confronting them is indeed anything but encouraging. The local streams and lakes which offered a natural means of supply are either too small or have been polluted from various causes. Some cities are using these impure waters after filtration. Other cities are getting a meager supply of ground water by means of driven wells, but as a permanent, stable supply both are mere makeshifts and cannot prove satisfactory or sufficient in the long run. Especially is this criticism true of driven wells or ground water supplies, for although the water is of good quality, it is too limited in quantity to furnish an adequate supply for manufacturing, street sprinkling, fire extinguishment, sewer flushing, power, etc.

Not only is water of good quality limited, but it is far too valuable for many of the uses to which it is put, even for some domestic purposes, for which an inferior quality of water would answer just as well. Bearing in mind the scarcity of good, clean, wholesome water and its dire necessity for drinking, cooking, etc., is it not sheer waste of a valuable commodity to apply it to uses where common, ordinary, untreated water from brooks, rivers and ponds would suffice?

Wisdom of Conserving Pure Water

Vast sums of money are expended to make water potable, and then it is applied to the extinguishment of fires, flushing sewers and various like purposes, altogether a different use than that for which it was rendered suitable at a considerable cost. This is certainly not in the line of efficiency or economy.

A consideration of these facts must convince anyone of the prudence, economy and wisdom of conserving the good water for the purpose which nature intended it, and supply for manufacturing and fire service purposes a water which can be obtained at much less cost. In other words, another system of water works should be built and separate pipes laid to convey water for many of the uses for which purified water is now consumed.

The Dual System of Supply

This means what is sometimes called a "dual system," and is objected to on account of its alleged excessive cost. The word "alleged" is used advisedly, because no thorough study has ever been made of comparative costs.

Answers to Criticisms Against Dual System

It is undoubtedly true that the cost of laying two mains would be greater than laying one main of equal carrying capacity and that two service pipes would enhance the expense for supplying water, but it does not follow that a dual system would require double the outlay of a single system, as some people maintain. For instance, large reservoirs at high elevations and large pumping plants are the outcome of the demands of underwriters for extreme high pressure for fire extinguishment, and are not necessary for the supplying of water for domestic or commercial use.

It is urged against the dual system that there isn't space in the streets for any more structures than we have; still, all the very large cities like New York, Boston, Philadelphia, etc., have high-pressure water mains in their streets in addition to the regular water mains, together with subways and many other structures, so that is not any great obstacle.

The point of this discussion is that when cities having a practically complete water works system, both for public and private service, are forced to improve the quality of the water supplied because of its menace to public health, instead of undertaking to purify their old supply, procuring a new and safe source adequate to supply their total consumption, plans should be made for the design and erection of an additional system for supplying a pure, wholesome water for drinking, culinary and laundry purposes. The first cost of construction would not then appear so appallingly large and the cost of operation would figure out to be less than the cost of maintaining and operating a huge single plant with its attendant large expenditures for filtration and purification of the quantity of water needed for every use; also, pumping all the water against high pressure for fire service when only a small portion of it is consumed for that purpose, would be avoided.

Probably the best plan of a Dual Water Works System would be to build a separate system for fire service and operate the old plant, with modifications, for all other purposes.

A Specific Example

I have in mind a city of 100,000 people consuming an average of 6,000,000 gals. daily. The supply is ground water, cool, soft, clean and wholesome but limited in quantity to about 10,000,000 gals., leaving but a small margin of supply over consumption especially during periods of excessive consumption. To increase the supply is imperative as the city is growing rapidly but the prospect of getting enough ground water is very doubtful. In case the wells fail to yield a sufficient supply, the only alternative is a source of supply 30 miles away, which would cost about $2,000,000 for a single pipe line to bring this water into the city.

My idea would be to conserve well water for domestic purposes and go back to the old river supply, which served the city before the wells were installed, for manufacturing and for fire and other public uses. By following this plan, well water would prove sufficient for many years to come because of the saving in its use.

Like in many other cities, the manufacturing, business and high value district generally is centrally located and could be served for fire purposes without excessive cost as far as laying new main pipe is concerned. Also, the hydrants in the residential sections could be allowed to remain as they are and not signify much in the consumption of water.

I know of no place where the Dual System of Water Supply is in use, but I believe the subject is well worth study and investigation.

The Mechanical Cleaning of Water Mains in Rochester, N. Y.

By Edward H. Keith, Resident Engineer, The Underwriters' Bureau of the Middle and Southern States.

Rochester, N. Y., a city of about 275,000 population situated along the Genesee River, seven miles from Lake Ontario., is provided with a double system of water works; one for fire service only and one for both fire and domestic service. The former is a district pumping system and takes its water from the Genesee River. The latter is a gravity system supplied from Hemlock Lake about 30 miles distant.

Cleaning Fire Service Mains

It is the cleaning of the fire service mains or "Holly" system that is of special interest at this time on account of the serious obstructions found in that system.

The Genesee River flows through a clay and limestone country and at times the river is very roily, bringing down large quantities of mud, clay and leaves, and the water is pumped directly into the mains without filtering or even passing through a settling basin.

Sprinkler Equipment Full of Mud.

A few years ago during the dismantling of the sprinkler equipment in an old building, the writer noticed an accumulation of sediment in the smaller sprinkler pipes and on a more careful inspection many of the smaller pipes, 2 in. and under, were found completely filled with mud and clay. This started an investigation of all of the older sprinkler equipments and many of them were found in the same condition.

The worst conditions, however, were found in systems that had a gravity tank for a second supply and the gravity tank feeding into the sprinkler system from the top of the riser instead of from the bottom as the modern practice requires; the gravity tank being filled by an independent line provided with a float valve. In some cases the upper half of the gravity tank was used for flushing the toilets throughout the building and there was a constant flow of water into the tank and the sediment settled to the bottom gradually filtering down into the system and in time filling the laterals and cross mains with a compact mass of mud and clay.

Some of these older systems were entirely removed and replaced by modern systems while others were cleaned out by flushing or scraping or by forcing wires or plungers through the pipes; in some cases it was necessary to remove the pipes before the sediment could be dislodged on account of its compact condition.

Investigation of Street Mains.

The discovery of the condition of the sprinkler systems led to an investigation of the street mains and for some time, whenever a cutout was made in the mains the writer was present and noted the condition; in some cases the mains were found free from sediment but in many cases from 1 to 4 ins. of sediment was encountered.

The "Holly" or Fire service mains were laid about 45 years ago and until within a few years before the writer started his investigation, had never been cleaned. In talking over the conditions of the mains with a former Mayor of the City he remarked that the most disconcerting fact was that he had never dreamed that such a condition was possible.

Cleaning Domestic Mains

In 1908 about 13,000 ft. of 6, 8 and 10 in. mains were cleaned in various parts of the city; again in 1909 and 1911 about 22,000 ft. were cleaned by National Water Main Cleaning Co., of New York. Nothing further was done until 1916 when owing to some complaints of dirty water in the domestic service mains, the same cleaning company were called upon to clean about 16,000 ft. of 6 to 20 in. domestic mains. Only a small amount of sediment was found although there was a considerable amount of tubercle scale or rust. In some places, however, the water discharged during the cleaning was very black.

Cleaning Fire Mains.

The writer took advantage of this work to ask the Water Department to clean some of the "Holly" mains in the vicinity of the risks where most serious conditions had been found in the sprinkler systems. About 4,500 ft. of 6 and 8 in. "Holly" mains were cleaned and from 2 to 4 in. of sediment together with a considerable amount of tubercle scale was found. In an 8 in. main that had been cleaned 8 years before 4 in. of sediment was found and the Cleaning Co., stated that this same amount of sediment was encountered at the former cleaning. The cleaning of the "Holly" mains was continued in 1917 and the work of cleaning was started in a more systematic manner and conditions that were not thought possible were discovered.

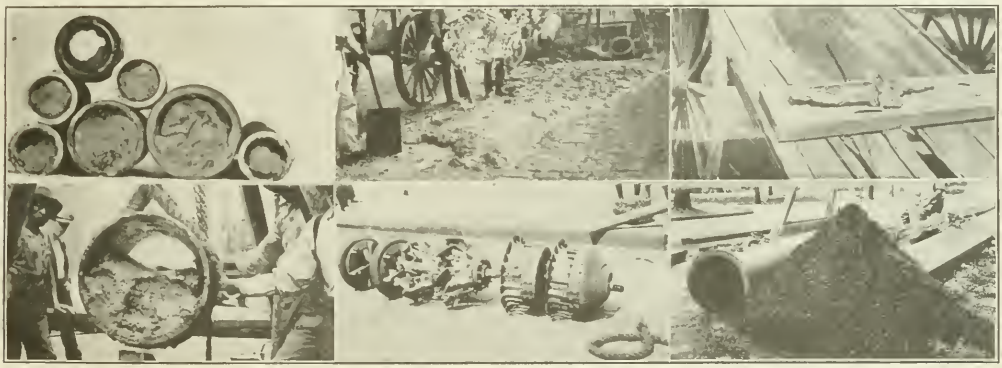
Sediment in Mains.

Starting at the pumping station the 20-in. feed main was entered and little or no sediment was found, but a considerable amount of sponge growth was encountered; this condition continued until the first right angle bend occurred a distance of about 600 ft., when sediment began to appear and for a distance of about 2,000 ft. to the central distribution point from 4 to 12 in. of mud and clay were found. Where the greatest amount of sediment occurred, the 20 in. main was reduced in cross section area 75% and the carrying capacity of the main reduced 50%.

After the cleaning machine had been sent through the main the street was covered from curb to curb for over a block with mud, clay and scale. The main at this point reduced to 16 ins. and while only a small amount of sediment was noticed at the cut out, the sediment came out in large chunks and there was so much of it thrown up into the street that it had to be removed by the wagon load.

Tubercle Scale and Rust.

This condition occurred in the lower portions of the City. Further away from the pumping station and in the higher portions of the city there was less of the sediment but a considerable amount of tubercle scale or rust was encountered.



VIEWS OF MATERIAL REMOVED IN MECHANICAL CLEANING OF WATER MAINS AT ROCHESTER, N. Y.
Top Row (Left to Right): Sprinkler Pipes Filled with Sediment. Mud and Clay Removed by Cleaning Machine. Surplus Lead Found in Main. Bottom Row: 12 ins. of Sediment in 20 in. Main. Cleaning Machine or "Go-Devil." Pile of Tubercle Scale and Rust Removed.

Excess Lead in Mains

In the cleaning of the mains several interesting conditions were found; conditions which could be discovered in no other way and which affected the integrity of the distribution system. For instance, in forcing the cleaning machine or "Go-Devil" through the mains the machine on several occasions suddenly stopped and on digging up the street, after determining its location by measurements, and breaking into the main, more or less lead, used in calking the joints, was found on the bottom of the main—as much as 40 lbs. being found in a single piece. In one instance, in a 6 in. main a piece of lead 16 ins. long and 2 ins. thick was found. This had effectually stopped the machine and was found partially curled up by the cleaning blades. In other instances partially closed gate valves were encountered.

The sedimentation of these mains had been going on for years and it is quite probable that the 12 ins. of deposit found in the 20 in. feed main had been in the main for many years and had reached a point where the velocity through the restricted area was sufficient to prevent a further deposition and had thus maintained an 8 in. clear water way.

Method of Cleaning.

In the cleaning of these mains the following method is observed: After shutting off the water, the main is uncovered and opened up in two places and a section at each place removed. The distance between the cuts varies according to the general conditions of the mains, the character and size of the cross mains, the angle of curvature at the bends, etc. A "go-devil," or cleaning machine, is placed in a new piece of pipe the same size and length as cut out; this is made up and leaded in as a permanent part of the main; at the other cut out, which may be 100 ft. 5,000 ft. or several miles distant, a riser pipe, of the same size of the main is made up and extended to the surface with a 45 degree bend.

Cleaning Machine Water Propelled or Cable Drawn.

When all is ready, a gate, near the place where the "Go-Devil" has been inserted, is partially opened and the "Go-Devil" is shot through by water pressure and comes out through the riser pipe. In some cases instead of shooting the "Go-Devil" by water pressure, it is drawn through by cable and windlass, a steel rope to which the machine is attached having been previously shot through by special carrier.

Removed Material Flushed Out Through Riser Pipe.

With either a cable drawn or a water propelled machine a certain amount of water is allowed to pass the machine in order to carry ahead of it the dirt and incrustations which have been cut and ground up by the machine and this sediment and cleanings are carried to the surface of the street through the riser pipe. After the machine has passed through the main the water is shut off, the riser pipe removed and the main at this point reconnected and all valves again opened. During the cleaning all valves in the cross mains are also closed and men are stationed at the various shut off gates along the line of the main to be cleaned and provided with telephone receivers to note when the "Go-Devil" passes those points.

Successful Application of Producer Gas Engines in Water and Electric Light Plant

The Vassar light and water plant in Vassar, Mich., has two Bruce-Macbeth producer gas engines of 75 and 125-h.p. capacity, operated by a producer which uses coal and automatically generates gas. Splendid results have been secured with this plant. Walter Clingenpeel, superintendent of the plant, is much pleased with the way the engines are working and he pronounces them easy to handle and says they are economical in fuel consumption. When the old plant closed down in August, 1917, it was using more than 5 tons of coal

in a 14-hour run. At the end of November, using the new gas engines, the plant was burning only from 900 to 1,200 pounds of coal per day of 24 hours. This not only indicates a big saving in fuel, but one man less is required to run the new plant than was employed in the old. Clingenpeel states that the city council and citizens are much pleased with th come, and in these times of fuel scarcity he advises othe to buy Bruce-Macbeth engines and Milwaukee Relian producers. He states that they make a good combinati prove highly satisfactory as well as economical and effici

Water Purification and Sewage Treatment

Industrial Waste Problems with Reference to the Smaller Cities

By Langdon Pearse, Division Engineer, the Sanitary District of Chicago, in Charge of Sewage Disposal Investigations.

With the growing attention given to the question of sewage treatment from the standpoint of the municipality to avoid nuisance or reduce pollution of water supply, interest is increasing in the problem of handling industrial wastes. Such wastes are not necessarily an indication of uneconomical operation on the part of the manufacturer, but may be a condition which has come down from the time when the pollution of streams was not so closely watched by the federal, state or municipal authorities. In many cases, however, the attention of the manufacturer has been drawn to leaks through the stoppage of which valuable sources of revenue have been found. The purpose of this article is not to deal in extended details of treatment, but to sketch briefly the problem found in different conditions and the general lines of action followed to obtain relief.

There are two general aspects, one the sewerage or sewage treatment problem, with many ramifications, which is commonly met, the other the water supply problem where industrial wastes pollute water used for drinking purposes.

Water Pollution by Industrial Wastes

The cases of water pollution are not so frequent. A few which have come to my attention may be of interest. In Maine, the sulphite waste liquor in the Kennebec gave the river water a slight taste or odor as used at Augusta. As the river was badly polluted with sewage, other sources of water supply were obtained. Along the shore of Lake Michigan, the wastes from a corn products factory in Waukegan at one time caused much complaint. Some alleviation was had through lime treatment. The factory burned down and has not been rebuilt. At Whiting, Ind., the small amount of material escaping from oil refineries gives the water a decided kerosene odor or taste. Experiment has shown that this can be removed by aeration and proper coagulation, followed by rapid filtration. At East Chicago, Ind., certain directions of wind blow surface currents to the intake from the outlet of quench water from coke ovens of large steel companies. This quench water apparently produces an odor or taste akin to the after taste or odor of an excessive dose of chloride of lime. In other parts of the country rivers may become salty from the waste from oil wells. Where possible, different source of supply should be sought; otherwise remedial treatment should be studied.

Effect of Industrial Wastes on Sewage Problem

From the sewage standpoint, there are several points at which the city officials may confront the manufacturing problem. First arises the question of maintenance of sewers to avoid deposits, deterioration of structure, freedom from local nuisance, and freedom from explosive gases, or gases dangerous to workmen in the sewers. Next is the problem of disposal. If the town is happily situated on a body of w ample diluting capacity, the problem is simple. Often u ment is required, or the removal of floating materi suffice. Where the town is so situated that treatme necessity, the problem is usually complicated by the p of industrial wastes. Only a careful survey of the si followed perhaps by actual tests, can indicate the step taken.

Classification of Industrial Wastes

The various industrial wastes may be briefly classi follows from the physical as well as from the chemica point:

1. Wastes carrying sediment.
   a. Heavy mineral matter such as marble dust, sto ashes, etc., usually inert.
   b. Heavy organic matter, largely of vegetable origi as refuse from canneries, pulp, distillery refu This may be putrescible.
   c. Heavy matter produced by chemical re-action, et as tarry wastes from gas works, residues fr monia works, etc.
   d. Heavy organic matter of both animal or vegetable such as Stock Yards or Packingtown wastes may be highly putrescible or comparatively in
2. Wastes carrying little or no sediment.
   a. Containing soluble organic matter. This may be putrescible.
   b. Containing chemicals.
      1. Eager to absorb oxygen.
      2. Inhibiting bacterial action.
3. Wastes carrying both suspended and soluble matt
4. Wastes carrying floating materials.
   a. Volatile and inflammable, as for instance gas kerosene.
   b. Fats and oils.
   c. Light organic matter.
   d. Light matter the product of chemical reaction, ing material from gas wastes, etc.

Industries Producing Wastes

The various classes of wastes covered by the fo summary may include a wide range of industries, wh be briefly mentioned, as follows:

Stock yards, slaughter houses, (including packing and allied concerns), poultry dressing houses, sausag factories, wool scouring and pulling, glue works, butte tories, gas works, tar-roofing works, makers of sta other corn products, tanneries, wire mills, foundries, br distilleries, beet-sugar works, dairies, marble work and dye works, oil refineries, canneries, strawboard an mills, and garages. In almost every form of industr water is used for other than cooling or condensing p some waste is added to the outgoing water, the imp of which from the standpoint of the maintenance of se sewage treatment works or the pollution of streams be determined by inspection or analysis.

Effect on Sewer Operation

From the standpoint of operation of the sewer system itself, the problem may quickly become prominent by accumulation of large amounts of deposits. In Fort Worth several years ago paunch manure from the stockyards choked up a 24 in. sewer pipe for several hundred feet, flooding backyards in the vicinity. Refuse from the canning industries may make deposits where waste pulp and spoiled fruit are deposited in the sewer. A very frequent cause of trouble is spent-lime from tanneries. The stand and sediment from stone-cutting operations may also cause deposits, and occasionally deposits are traced to strawboard factories.

Volatile Material Reaching Sewers

There is also the important question of reducing the amount of volatile material which may reach the sewer, particularly gasoline. Of late years, a number of disastrous explosions in sewers have occurred traceable to gasoline. Leaky gas pipes have also proven a source of trouble, but not so markedly of late as gasoline. In Chicago, a trap or skimming basis with three compartments provided with baffles under water is required on all garages to hold gasoline or light oils which might enter the sewer. Similar traps or skimming devices of larger size are also in use in tar-roofing industries, oil refineries and gas works to retain floating tar. In engine rooms oil is occasionally wasted and spent oil discharged into the sewer. Oil traps will prevent this. Further many cities prohibit the discharge into sewers of steam or trade wastes at high temperatures.

Explicit Chicago Ordinances Regulating Use of Sewers

On both the foregoing points, the municipal ordinances of Chicago are decidedly explicit.

"Section 790. Steam discharge in sewer prohibited. No person shall make or use or cause to be made or used any connection with or opening into any sewer or drain for the conveyance or discharge into such sewer of drawn-off steam from any steam boiler or engine, or from any manufactory or building in which steam is either generated or used, under a penalty of $50 for each and every day during any part of which such connection or opening may have been used for that purpose."

"Section 791. Obstructing sewer penalty. No butcher's offal or garbage, dead animals or obstructions of any kind whatsoever shall be placed, thrown or deposited in any receiving basin or sewer, and any person so offending or causing any such obstruction or substance to be so placed so as to be carried into such basin or sewer shall be subject to a penalty of $10 for each offense....." While such penalties are small, it is to the credit of most offenders that they will spend many times such amounts in endeavoring to improve conditions.

Effect on Sewers of Acid Wastes

Sewers, also, should be watched where the discharge of acid wastes occurs. In most localities, the sewage is alkaline and there is generally sufficient alkalinity present to take care of ordinary discharges. As a general rule, threatened injury to sewers of whatever material, from the structural standpoint, has come from the generation of hydrogen sulphide due to putrefying deposits or exceptionally stale or septic sewage. These conditions may be induced by the presence of industrial wastes, although not necessarily. In the smaller sewers however, the discharge of acid wastes from the pickling vats in wire mills, foundries, sheet metal or pipe works may sometimes need attention, as the volume of domestic sewage may not be sufficient to neutralize the acidity. Such cases, however, appear rare. Neutralization may be adopted. Recovery of iron sulphate by evaporation is frequently practicable, where the volume is sufficient to warrant. The gradual outflow of wastes throughout the 24 hours of the day rather than sudden discharges may prove helpful.

Industrial Wastes and Stream Pollution

When the sewage enters the stream or other outlet for disposal, further developments ensue. Many industrial wastes have a high content of putrescible matter, which of itself will undergo intense putrefaction. Other wastes, though high in organic matter, may be of themselves practically sterile, but when mixed with domestic sewage or a polluted stream, rapidly decompose. Included in such wastes may be the starch or corn products wastes, which furnish excellent food for bacterial decomposition. Consequently the bacterial content of a waste or sewage, is not necessarily regarded as an important index, except where the pollution of a water supply, or contamination of bathing beaches or shell-fish beds are in question. Wastes rich in corn products, sugar, etc., while in themselves seemingly harmless, when broken down by decomposition, may produce most offensive nuisance, and often prove the most difficult to abate.

Effects on Fish Life

In considering the effect on a stream, the demand for oxygen, is of course, important as an index to the dilution capacity of the stream at various stages. The exhaustion of the oxygen points to probability of nuisance, and further the death of fish. Aside from this extreme condition, even where considerable oxygen is present, from the standpoint of fish life, certain wastes particularly from gas works are highly deleterious. Gas and tar refuse are particularly damaging, even in small amounts, since they tend to give the flesh of the fish a tarry taste which may make them wholly unfit for sale. This is particularly noticeable where a gas works discharges into water which otherwise may be very suitable for fish life.

Floating Wastes Objectionable

The importance of retention of floating wastes is readily apparent. Grease, oils, and tar have a definite value, in normal times, which is much greater in these war times. Furthermore the slick of oil or grease spreads widely in a stream, and quickly occasions unfavorable comments. Yachtsmen also complain of the discoloration of their boats by such forms of refuse.

Effect on Navigation

From the standpoint of navigation in a stream below the discharge of the sewer, the amount of sediment, particularly where inert may prove of importance. This is particularly true where the sewer discharges into streams of low velocity or slack water. A large glue works alone may discharge over two tons of lime a day, or perhaps as much as 20 cu. yds. of sludge a day. Beet sugar works, packing houses and tanneries may also be large producers of sludge.

Local Nuisance

In most cases, the complaints of nuisance come from objectors situated along the stream below a town, or inside the municipal boundaries. Occasionally the question may arise of nuisance caused by the discharge of industrial wastes into the city sewers in the city itself. For instance, in Decatur, Ill., considerable complaint along the line of a trunk sewer has been caused by the discharge of starch wastes into a domestic sewer which then flows about two miles through the city to the outfall. The only way to satisfy public opinion was the complete diversion of the waste from the city sewer, into a closed sewer extending to the outfall.

Skimming and Catchbasins

From the standpoint of the local sewer system, ordinances are generally drawn to operate under the police powers of the municipality in the regulation of the discharge of wastes. Most acts of this character have been directed toward prohibition of sediment by the requirements of catchbasins or directed toward the retention of floating matter by suitable skimming basins. In some cases special action toward direct removal of wastes from the city sewer has been needed, as in

the case of the wool wastes of Hudson and the starch wastes of Decatur. Organized removal of sediment by catchbasins from tannery centers is well illustrated by the basins of the tanneries on the North Metropolitan sewer in the Metropolitan Water and Sewerage District serving Boston and its surroundings where from 5,000 to 8,000 cu. yds. of sludge are removed yearly. In Gloversville, N. Y., where tannery wastes are especially prevalent, catchbasins have been required in order to prevent deposits in sewers and reduce the load on the treatment works. In both cases the preliminary treatment was needed to insure the operation of the sewers.

No Established Standards for Treatment

At present there are no established standards for treatment. An inquiry by the author, several years ago, as to general practice in such matters brought out the fact that in most states the engineering heads of the various State Boards of Health solve each case according to its merits. A study of the literature on the subject shows a variation in the standards of treatment proposed, those by the Royal Sewage Commission in England being especially severe. The general trend, however, seems to be toward a more complete treatment of the wastes as time goes on. Thirty or forty years ago in England many of the so-called sewerage districts were organized under acts which were exceedingly liberal in their viewpoint toward the manufacturer. Under the old River Pollution Prevention Act (1876), the local boards were required to have regard to the industrial interests in the case and the circumstances and requirements of the locality. It is not clear how far the individual conditions were to govern nor the costs of treatment. To-day however, the English practice has swung the other way, under more recent statutes, the manufacturer being required to do more and more. In the decision concerning the Tanworth, Birmingham and Rea Drainage Board, 1909, the Court took the position that sewage treatment should be sufficient to make the effluent as good at least as the character of the stream. This has been taken by some as an index for treatment of industrial wastes. In the specific case of Gloversville, N. Y., the standard adopted required the effluent from all tanneries to be at least as low in content of suspended matter as the city sewage before such wastes were discharged into the sewer, the final treatment being given in municipal works. In other cases, the requirement of a non-putrescible effluent has been made, where conditions of stream pollution controlled.

Remedial Measures

Remedial measures in general may be based on

1. The reduction of the volume of the wastes as much as possible, except where dilution is helpful in promoting ease of treatment.
2. The discharge of wastes at low rates, continuously, instead of in sudden outflows.
3. The provision of screens, either coarse or fine or both. Where more material must be removed, settling tanks, either alone or combined with screens, may prove useful, arranged for the convenient removal of the sludge. These details depend on the industry.
4. The provision of further treatment, either separately or mixed with the domestic sewage, according to accumulation. Under this head would come the use of all kinds of biological treatment, intermittent sand filters, sprinkling filters, activated sludge and the like.
5. The elimination of the waste by evaporation. This has been done on a few wastes where the value of recovered material proves worth while.

In particular a few typical industries may be cited:

Tanneries

Preliminary settling is helpful either in hopper-bottom tanks or possibly in shallow tanks of the Dorr type. The sludge may be drained on sludge beds. The treatment must be adapted to the processes used in the tannery. Activated sludge has been used with success in an experimental plant. Other biological processes are adaptable.

Packing Houses

Preliminary screening is decidedly helpful in removing solids. The skimming of grease is also essential. Further treatment may be had in settling tanks, but the most promising development appears to be in the activated sludge treatment. This will give a high-grade effluent, if desired, and a sludge which can be recovered in all probability at a cost which is less than the value of the dried sludge as a fertilizer.

Canneries

Careful study of the processes may show means of holding back material. Pulp and other refuse should be treated as garbage, instead of dumping into the sewer.

Treating Industrial Waste and Sewage Together

From the standpoint of the smaller town called upon to treat its own sewage for the purpose of avoiding stream pollution, the question of receiving industrial wastes into its sewers or plant becomes of considerable importance. Foremost is the question of cost. Not alone may the first cost of the plant be increased by the presence of wastes, but the operating costs may be increased. Certain classes of wastes tend to interfere with the successful working of biological treatment, and in at least one case (Hudson, Mass.) where wool-scouring wastes were discharged into the city sewers, the effect was so pronounced that they were ordered out. In another case for instance, Worcester, Mass., with acid sewage from wire mills, special treatment with lime is required.

Division of Financial Burdens Is Difficult

To the city official the division of financial burdens appears very puzzling at times. On one hand may be a large corporation paying a generous proportion of the taxes, and yet on the other creating a serious condition of nuisance which demands relief. This phase of the situation has developed further in England where the concentration of industry and population on small streams early produced intolerable conditions. The situation there has been complicated by certain technicalities arising when the wastes are discharged into municipal sewers. In many cities in England manufacturers desiring to discharge their trade wastes into the municipal sewers try to come to an agreement with the municipal authorities. Such agreements usually bear in mind the removal of suspended matter, floating matter, etc., and the removal or treatment of all constituents which will put additional burden on the municipal works in dealing with the mixed sewage. The practice is very varied. In some of the cities the waste is received after preliminary treatment, and when mixed with domestic sewage handled without charge. In Salford, for instance, the corporation undertakes to remove and dispose of any sludge collected in any preliminary treatment works free of any charge to the manufacturers. In other cases the industrial waste is received into the sewers without any preliminary treatment on the condition that the manufacturers pay the increased cost of the treatment works or the increased cost of operation, or both. On the other hand, outside large manufacturing centers, occasionally manufacturers are allowed to discharge trade wastes into the sewers without agreement and without charge or preliminary treatment. Changes in the laws were expected following the final report of the Royal Sewage Commission.

Burden of Cost on Manufacturer

In the United States, as in England, where wastes are discharged into a stream the burden of cost has generally fallen on the manufacturer making the waste. Where the wastes are discharged into a sewer system, preliminary treatment has generally been required, as noted, or occasionally

complete diversion, and separate treatment. The question of additional cost of further treatment has been regarded as a problem for local adjustment.

Lines of Preliminary Action

To aid in the study of the industrial waste problem, certain lines of preliminary action are helpful. The municipality should keep a record of all sewer permits, the industrial permits being classified. Further, each industry of size should be required to have as few outlets as possible, each provided with a manhole, readily accessible for inspection, sampling or measuring the flow. Where doubt is had as to the effect of an industry, competent expert advice should be secured, and suitable methods planned to overcome the difficulties. In some cases recommendations cannot be made until after extended study, and perhaps tests.

Importance of Tests

The importance of carefully executed tests on industrial or mixed sewages should not be overlooked in planning sewage treatment works, particularly where the methods of financing preclude any flexibility or quick increase in the size of the plant, if conditions demand later. Such tests are not so expensive as to be prohibitive for the smaller towns. There is usually little need of following the elaborate program of some of the large cities. The author has run special tests on removal of odors, from drinking water with apparatus costing as low as $500. But for any conclusive sewage treatment studies, from $1,500 up should be available for constructive purposes, in normal times. Under present conditions higher figures are necessary. The costs of operation will vary widely with the amount of waste and scope of the inquiry. Some of the smaller cities have spent the amounts in preliminary tests, shown in Table I.

TABLE I—COSTS OF SPECIAL INVESTIGATIONS ON WATER AND SEWAGE PURIFICATION.

Place.	Work	Date	Approximate Cost.
Waterbury, Conn.	Sewage.	1905-07	$14,000
Baltimore, Md.	Sewage.	1907-08	17,500
Oakland, Calif.	Water.	1907-08	19,390
Gloversville, N. Y.	Sewage.	1907-09	13,570
Akron, O.	Sewage.	1911-12	9,100
Decatur, Ill.	Sewage.	1914	5,500
Houston, Texas.	Sewage.	1915-16	5,524

Tests seem particularly necessary at present on the groups of wastes which are or by their fermentations tend to become acid,—such as the water from dairies; beet sugar works, corn products works and the like. The application of activated sludge to industrial packing house treatment requires careful attention, as the processes in different houses vary, and the character of the water used also appears to have an influence, particularly in the sludge treatment.

Successful Ultra-Violet Ray Sterilization of Henderson, Ky., Water Supply

At Henderson, Kentucky, sedimentation, coagulation and mechanical filtration are followed by ultra-violet ray sterilization and this treatment of the public water supply has been in successful operation for several months. The large, pressure-type ultra-violet-ray sterilizers in operation at Henderson, and here illustrated, are the first of this type designed for use in a city water purification plant. The sterilizer units are automatically operated. The illustrations and information relative to this plant were furnished by A. T. Smith, President of the R. U. V. Co., Inc., of New York City, who furnished and installed this sterilization apparatus.

Elements of the Plant.

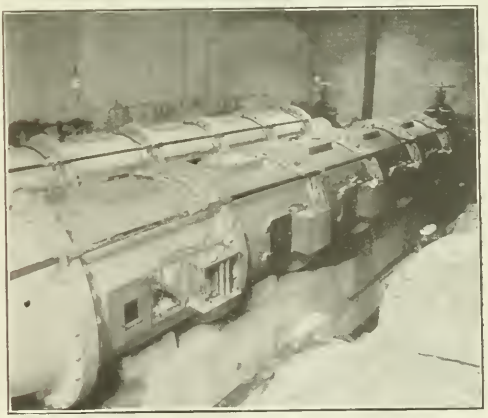
The City of Henderson, Ky., located on the Ohio River about 12 miles below Evansville, Ind., secures its water-supply from the Ohio River. It has a population of about 17,000. Up to 1916, untreated water was pumped to a 4,000,000-gal. reservoir. The storage was equivalent to less than two days' supply, the average daily consumption being about 2,500,000 gals. The City, after considering various schemes, finally acepted the joint proposition of the R. U. V. Co., of New York City, and the Pittsburg Filter Manufacturing Co., of Pittsburgh, for a complete sedimentation, filtration and sterilization plant at the pumping station site to have a nominal capacity of 3,000,000 gals. per day and designed to be increased to double that capacity without affecting the present structures.

Design of Plant

The design was passed upon by J. W. Ellms, consulting engineer, Cincinnati, Ohio. There are two coagulating basins, each 95 ft. long, 30 ft. wide and 15 ft. in depth; and two

VIEW OF WATER PURIFICATION PLANT, HENDERSON, KY., WHERE SEDIMENTATION AND MECHANICAL FILTRATION ARE FOLLOWED BY ULTRA-VIOLET RAY STERILIZATION.

baffled mixing chambers, 7½ ft. wide, 25 ft. long, and 17½ ft. in depth. The detention period in the coagulating basins is 4 hours on a capacity of 3,750,000 gals. per day, and the capacity of the two settling basins is 620,000 gals. Six reinforced-concrete filter units were installed, each 17 ft. long by 13 ft. 4 ins. wide, with a normal capacity of 625,000 gals. each, totaling 3,750,000 gals. per day. The filters are of reinforced-concrete throughout, with a brick building covering the filters and the head house. A clear-well covers the entire area below the fil-



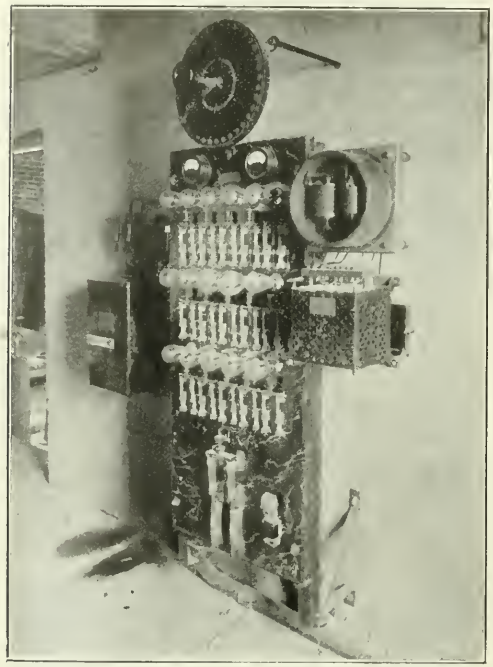
ULTRA-VIOLET UNIT OF LARGE SIZE USED IN HENDERSON, KY., WATER PURIFICATION PLANT.

ter units and pipe gallery. Adjacent to this on the outside, is a low re-inforced-concrete building, 17 ft. wide by 28 ft. long, in which is placed the ultra-violet-ray sterilization apparatus.

The Sterilizers

The ultra-violet-ray sterilizers consist of three legs, each comprising five units. The legs are connected in parallel, while the entire equipment is connected in series with the pipe

line leading from the clear-water basin to the sump from which the pumps draw their supply. Valved increasers and reducers are provided to connect the sterilizer with the service pipe line, as the sterilizer units are made 30 ins. in diameter to secure low velocity. Each unit has a lamp box inserted in its side, equipped with a clear quartz closed-end tube, which projects into the body of the unit and around which the water is forced to flow in a thin film, by means of a baffle placed at 90° to the long axis of the sterilizer. The baffle has a slotted opening to receive the quartz tube and to provide for passage of the water.



OPERATING AND INDICATOR BOARD, HENDERSON, KY., ULTRA-VIOLET STERILIZATION PLANT.

Inside the quartz tube is placed a 220-volt direct-current mercury-vapor arc lamp. It is properly held in place and automatically tilted by a special support which is located in the lamp box.

An iron baffle place with four large holes is inserted in each unit to insure bringing each particle of water into the field of the ultra-violet rays during its passage through the apparatus. Each lamp is provided with a small individual switch cabinet to provide proper electrical starting characteristics. A main switchboard is also provided and placed adjacent to the filter-operating room. This board has mounted on it a tell-tale incandescent lamp for each ultra-violet lamp in the sterilizer, main-line switches and indicating instruments. There is also a warning bell which rings when a tell-tale lamp is lighted.

If any ultra-violet lamp fails or diminishes in power from any cause, the bell rings and the tell-tale lamp on the main switchboard shows which lamp or lamps in the sterilizer are in trouble. A motor generator set is provided to transform the available alternating current into 220-volt direct-current.

Table 1 gives results taken from daily tests run continuously for over two months and are offered to indicate the effectiveness of the sterilizer. The bacteriological work was done in accordance with standard methods of the Laboratory Section of the American Public Health Association, and the average results were closely checked by the maximum and minimum obtained, which vary little from average results.

TABLE 1—TYPICAL RESULTS OF TWO MONTHS' TESTS ON EFFICIENCY OF STERILIZATION BY ULTRA-VIOLET RAYS AT HENDERSON, KY.

Sample	Total No. of Samples	Bacteria per c. c., 24-hr. Incubation: Total Bacteria Maximum	Total Bacteria Average	B. Coli Maximum	B. Coli Average
Raw	25	190,000	85,000	1000.0	276.0
Coagulated	25	1,200	720	100.0	45.0
Filter	70	320	80	1.0	0.035
Leg 1:					
Influent	52	95	32	1.0	0.260
Burner 1	48	30	16	0.8	0.215
Burner 2	48	20	8	0.8	0.200
Burner 3	48	16	6	0.2	0.136
Burner 4	48	6	2.10	0.1	0.090
Burner 5	54	3	0.31	0.0	0.000
Leg 2:					
Influent	53	75	36	1.0	0.310
Burner 1	47	50	12	0.6	0.273
Burner 2	47	20	6	0.8	0.18
Burner 3	47	7	5.20	0.4	0.117
Burner 4	47	6	1.80	0.1	0.07
Burner 5	54	3	0.38	0.0	0.0
Leg 3:					
Influent	54	95	25	1.0	0.326
Burner 1	47	55	14	0.8	0.240
Burner 2	47	19	9	0.8	0.21
Burner 3	47	12	4	0.4	0.110

The plant was put in operation toward the end of 1916 and has since run under a varying capacity from 2,200,000 to about 3,500,000 gal. per day. The current consumption guarantee of 0.77 per lamp was met in operation. The cost of final sterilization by this method can be estimated from the current consumption, which is 92.5 kw.-hr. per 1,000,000 gallons.

Burner 4	47	6	1.60	0.1	0.06
Burner 5	54	3	0.42	0.0	0.0
Tap at pump...	34	11	0.39	0.0	0.0

Rate of pumping 2,200,000 gal. per day to 3,200,000 gal. per day, with little or no variation in results.

Turbidity of raw water varied from 130 to 880 p. p. m.

Filtered water usually clear with maximum turbidity of 5 p. p. m.

Performance of a 2½-Ton 6-Cylinder Motor Truck

Two years ago a manufacturer of heavy machinery purchased a 2½-ton, 6-cylinder, worm drive truck which has made a fine performance record. The truck has no vibration, due to a 6-cylinder motor, a worm drive making a smooth and easy running truck. The truck is also easy riding due to semi-elliptical front and rear springs 2½ ins. wide and 60 ins. long. This truck is being used to haul freight to and from depots, and to haul castings from several local foundries. The truck makes four to five trips a day, always carrying capacity loads and sometimes over. The daily average run is from 60 to 70 miles, and the truck makes from 8½ to 9½ miles per gallon of gas and per quart of lubricating oil. The truck easily negotiates steep grades without shifting to intermediate gear. The truck under discussion is a Stegeman, equipped with an electric starter. This starter saves both truck and driver time, by eliminating hand cranking. The truck stops 40 or 50 times each day, and figuring 1½ minutes for cranking, the starter easily saves 50 minutes of the driver's and truck's time each day. The users, the Pawling & Harnischfeger Co., of Milwaukee, figure also a saving of 75 cents per day on gasoline due to the economy of the truck's operation.

WATER WORKS DESIGN AND CONSTRUCTION

Practical Hints on Various Features of Water Works Design

By J. W. Ledoux, Water Works Engineer, 112 North Broad Street, Philadelphia, Pa.

In such strenuous times as we are now passing through, the engineer having in charge the design and construction of water works under various conditions finds his viewpoint and standards subject to modification and uncertainty. What was practical a year ago is now impossible; he hesitates to specify this or that for fear that it cannot be obtained—the price may be changed over night or the government may commandeer everything connected with it. Manual labor of all kinds demands from two to four times the wages heretofore paid, and even then men cannot live as well as before on account of the high prices of supplies. People are beginning to cut down expenditures for luxuries and even for necessities, so that with all the extra demands for war supplies, industries are at any moment threatened with panic. Water works construction, then, necessarily is limited to improvements that are essential.

Influence of Present Conditions

Storage Requirements.—In the past, conservative engineers, when designing gravity supplies, provided sufficient storage to produce an ample supply during periods of the worst drouths on record. Today such reservoirs as they have are given credit for a supplying capacity such as will take care of the needs during average periods, and the engineer trusts in Providence to take care of him until normal times return.

Pumping Machinery.—The same principle is adopted concerning the pumps and boilers; if the demand for water increases, they are run to the limit of their overload capacity.

Filters.—Nowadays nearly all filters are mechanical, the slow sand type being what we might call a "back number." The rating of these mechanical filters is normally about 2 gal. per square foot per minute, but to take care of the peaks and maximum demands they are easily pushed up 50 per cent., and in some cases, especially with pressure filters, to 100 per cent. above their standard rating. The quality of the water may suffer, but the operators either take chances, depend upon chlorine, or once again upon the kindness of Providence, and thus it is all through. Expenses of operating the water works have increased like every other commodity, but the income cannot rise, because the rates are fixed by recently established tribunals, which act with extreme slowness and uncertainty, and so the water works managers can struggle along with inadequate service and on the ragged edge of accident and total disability. If the dreaded event takes place, and the public thereby suffers, the blame is placed on the "villians" who own the water works, and not on the system by which they are hamstrung.

Under these conditions the science of design and construction of water works cannot be approached with that broad spirit of substantiality that was heretofore the practice. Nevertheless, engineers cannot afford to allow such lowering of their standards to become a confirmed habit, and it is to be hoped that the conditions of the past, wherein the practice which was recognized to be the best, will soon be restored. In the meantime, as far as the war is concerned, our country demands our absolute loyalty and hearty co-operation.

Vital Elements in Water Works Design

The vital elements upon which the design of a water works depends may be given in the following order:

1. Financial consideration. 2. Water supply. 3. Means for supplying water from source into the distribution mains. 4. Distribution system.

The financial consideration involves the following questions:

1. How much income can be depended upon? 2. What will it cost to install the system? 3. What will it cost to operate it?

The first financial question is independent of the others, but the second is dependent upon the first, and the third upon the first and second; although, looking back over plants which have been in existence for a generation or more, we often wonder whether the projectors had much regard for financial considerations.

For the past five years it has been impracticable to float a water works proposition that did not show with a fair degree of certainty earnings in excess of 50 per cent. over the operating expenses, depreciation and interest on the cost.

In the past times—fifteen to twenty years ago—the formula was something like this: "People must have water; American communities are sure to grow, and even if we have to carry the works for one or two decades, we must eventually make a handsome profit on the entire investment."

As a consequence, villages and hamlets secured city size water works and were enabled to develop and grow by reason thereof. When they grew up to be a municipality or city they often forgot the utility which made their growth possible, and exerted themselves to discredit and depreciate their water works, knowing they were now able to build their own plants.

This attitude gave rise to the numerous devices for regulating rates by the municipalities, commissions, etc., so that the dreams of ultimate profit by the water works owners were seldom realized. Today no one in the least posted in water works finances would dare undertake the installation of a water works proposition unless the financial success of the venture were absolutely assured.

Sources of Water Supply

The water supply falls into many natural subdivisions. It may come from rivers or lakes, from springs, from the natural flow of streams, from storage reservoirs which equalize the flow of streams, from shallow or deep wells, or from the salt sea.

Rivers and Lakes

The difficulties and risks involved in the other sources are so great that many very good engineers prefer to obtain the supply from large rivers or lakes. There is much to be claimed for this practice. Usually the water from this source is of unsatisfactory quality, without complete purification, but the one vital question of adequate supply has been settled for all time, and its purification is only a question of well-known mechanism, chemicals and attention at a not prohibitory expense.

Springs

Although many water works report them as such, there are comparatively few plants whose supplies come from springs. As far as quantity is concerned, a town or city is fortunate to possess this kind of supply, because the flow usually flue-

tuates little and the quality of the water is constant. In most cases, however, the water is notoriously hard, as the supply generally comes from subterranean sources, through fissured or cavernous limestone formations. A few notable examples are: Boiling Springs, near Carlisle, Pa., flow nearly 20,000,000 gal. per 24 hours; Roaring Springs, above Hollidaysburg, Pa., 6,000,000 gal.; springs supplying Bellefont, Pa., Bristol, Tenn., Roanoke, Va., 7,000,000 gal. per day; Jacksonville, Fla.; Phillipsburg, Pa., water works; Allentown, Pa., water works; Bethlehem, Pa., water works; Bennetts Springs, the head waters of Niangua river, Missouri, flow 170,000,000 gal. per 24 hours, and Hahatonka Springs, farther down on same river, flow 160,000,000 gal. per 24 hours.

With the exception of Phillipsburg, Pa., which is clear, soft water, in every one of the above cases, and there are many more, the water is clear, comes out of limestone formation, is quite hard and maintains a fairly steady flow.

Streams

When a stream is large enough without storage to afford a reliable and steady supply for a large town, it practically comes under the category of a river. The engineer, however, must be on his guard, because the past records of flow may be unreliable and not sufficiently prolonged to cover such extremes of flow as occur and are vital to the success or failure of a water works. The most important considerations are a study of the rainfall and its distribution, the drainage area, and, lastly, stream measurements, if such be available. If not, an actual gaging should be made to obtain the daily, weekly or monthly flow from one wet season to the next, coincident with the rainfall. Then calculate the flow for the critical cycle of years by the unsurpassed method described by Vermeule in "Water Supply," New Jersey Geological Survey, 1894.

Storage

In order to make any satisfactory estimate of the storage required to insure at all times a given yield from a known drainage area, it is first essential to have a diagram of the monthly flow covering a period containing the cycle of lowest flow which is likely to be experienced. With such data there can be prepared a mass diagram, which consists in plotting the total flows up to the end of each month. For instance, if the flow in inches per square mile for the four years up to June 30 were 40 in. and the flow in June were 2 in., July 1.50 in., August 0.75 in., September 0.30 in., the plotting would be: June, 42; July, 43.50; August 44.25, and September, 44.55 in.

We can plot on the same diagram in the same way the total estimated consumption, or "draft on storage." The maximum distance between these two diagrams will be the storage required.

The preparation of such a table involves much time and labor, but the information is invaluable, and a dozen or more well distributed over the country forms an essential part of the equipment of the experienced water works engineer.

Limitations of Storage Tables

It is, however, not safe to use these tables with confidence that they will apply perfectly to other streams having apparently similar physical conditions. For instance, there is a vast difference between the Perkiomen and the Tohicken creeks. In Dauphin county, Pennsylvania, there are three parallel streams—Stony creek, Clarks creek and Powells creek. Their watersheds are similar in size and geologically. Stony creek has very little forest as compared with the others; Clarks creek and Powells creek are similar in that respect. Clarks creek and Stony creek have very similar characteristics of flow, but the dry season flow of Powells creek is only about half that of Clarks creek for the same unit of drainage area. Similar discrepancies are encountered all over the country, so that the engineer has to be very careful in applying the results of one drainage area to that of another one, although similarly situated; that is the reason why one season's gagings of the stream itself is of vital importance to arrive at the characteristics of flow.

It is well here to offer a word of caution concerning the published records of stream flow. While much of it is authentic and reliable, such, for instance, as the Sudbury, Croton*, Perkiomen**, Neshaminy**, Tohickon** and many streams, especially in the arid region of the west, still there is a vast amount that is misleading and dangerous in the hands of men having implicit faith in its reliability. That is why a proper study of the rainfall, which is usually reliable, is of great value as a check.

Stream Gaging

Where it is desired to gage a stream the writer recommends for small streams the use of weirs; for large streams and rivers either pitot tubes or current meters, but if the stream is turbulent and fluctuates in flow from moment to moment, the current meter should be extremely well made and have its moving parts as light as possible, so as to avoid inertia and consequent over-registration. Otherwise there is a possibility of 25 to 50 per cent. error.

The chemical method of gaging is occasionally applicable, but for large streams is very expensive and difficult of application, and unless every possible check is applied the results are uncertain. Under suitable conditions it is the most accurate method ever devised. The ideal situation for its adoption is a rapidly flowing, turbulent stream, with a bridge over a narrow section at the applying station and a bridge at the sampling station down stream.

Well Supply

Many important water works obtain water from either shallow or deep wells. In most of these cases the water is of excellent quality and really safer from a sanitary standpoint than any system of filtration or purification. Many people have an idea that artesian wells can be sunk anywhere and provide an ample supply of good water. That, of course, is not the case; where the geological formations are below the sedimentary rocks artesian wells will yield too little water to be worth while. In many of the upper formations the water is so charged with iron, sulphur, soda or other chemicals as to be unfit for use. Even where the rock formations are suitable the success of the well is problematical. In arid countries, like parts of Texas, New Mexico, etc., they afford the only possible and practical supplies. Those supplies which come entirely from flowing wells are so rare as to be hardly worthy of consideration. Shallow wells have their application where there exists within 50 ft. of the surface a bed of coarse sand or gravel tributary to a large drainage area, or where these porous strata are along the bank of a river or lake.

Frequently this kind of supply diminishes in available yield, probably due to the closing up of the strata by the process of filtration, so that most water works which originally adopted shallow or infiltration wells eventually abandon them and either obtain a new supply or go directly to the river which was supplying the infiltration water.

The science of wells is vast, interesting and complicated, and an instructive and practically useful history could be written concerning every such single plant in the country.

Sea Water Supply

There are few situations in the United States where some kind of a fresh water supply is not available. Along the southern Atlantic coast there have been salt water tidal streams dammed and thereafter successfully used for a water supply. The city of Norfolk, Va., and the city supply of Charleston, S. C., afford good examples. In the latter case a

*The drainage area of Croton, as published, is said to have a material error.

**The reliability of the stream flow records has been questioned, but the writer believes the data can be taken as approximately correct.

tidal stream draining about 50 square miles was dammed at a point on the tidal salt marsh about six miles down stream from permanently fresh water. When the dam had been completed the contents of salt above the dam were about 1,000 parts per million, but in two months, by the aid of a centrifugal pump and the natural fresh water dilution, the salt was reduced to a hundred parts per million, and in two years, without other assistance than the regular pumpage of water at the rate of about 3,000,000 gal. per day, the content of salt was reduced to fifteen parts per million, which was the normal salt in the fresh water portion of that stream. The experience of the city of Norfolk was similar. It may be remarked in passing that when the content of salt is over 800 parts per million it is readily perceptible to the taste, and when it is below 150 there seem to be no bad effects of any kind from its use.

Where it is necessary to take the water directly from the sea or from a supply which cannot be diluted sufficiently with fresh water, the only practicable plan is to distill the water. Ordinarily 1 lb. of coal will evaporate and distill from 6 to 10 lbs. of water, but by the well-known multiple process 1 lb. of coal will readily distill 25 lbs. of salt water, and in extreme cases up to 50 lbs.; so it is commercially practicable to furnish a city water supply even when only the ocean is available, provided the citizens are willing to pay $2 per 1,000 gallons, which, after all, is not a high price for such precious fluid.

Means for Supplying Water Into Delivery Mains

These consist of the intakes, head works, dams, pumping and filtration plants and delivery mains. To discuss these in all their ramifications would require a volume, but a few hints under each heading may be of interest.

Intake Pipes

In a lake supply the intake pipe is usually carried out far enough to reach a depth below grounding ice—from 15 to 40 ft. This is also necessary to get beyond shore contamination. If the lake be navigable the intake crib as well as the pipe itself must be protected from dragging anchors. Therefore it is necessary to lay most of the pipe in a trench. To make the joints tight the services of divers are necessary. There are few, if any, divers that can make up the joints in all cases water-tight, so, in order to repair such leaks as occur, it is very necessary that the pipe be tested at intervals by plugging the unfinished end and pumping air into the pipe. If the lake is not too rough the leaks can readily be located by the air bubbles. Finally, the extent of the leakage can be determined volumetrically by means of a barrel or tank from which water is emptied through a small pipe into the shore end of the intake pipe. It is unnecessary to say that these intake pipes should be laid at every point with either an ascending or descending and perceptible grade, so as to avoid air pockets.

Intake Towers

In large reservoirs intake towers are considered the best practice, as they readily enable the water to be shut off, or screened, or taken at any desired level, by providing valved openings at the necessary elevations in the tower. In rare cases this latter object has been accomplished by a swinging intake pipe, the inlet end being supported by a large float, which maintains the opening of the pipe at a constant depth below the surface of the water. The average water works has neither tower nor swinging pipe and takes the water at a constant level near the base of the dam.

One of the most troublesome situations is to provide satisfactory intake works for a river like the Ohio, subject to a rise in many places of more than 60 ft. There have been numerous devices used with more or less success, one of the most novel and probably troublesome being the slope railroad, on which is located a car containing the pumping engine. On the side of the track is located a steam pipe, discharge pipe and suction pipe, running down the slope to a point below low water, each having at suitable intervals the necessary openings with which to connect the pump by means of flexible sections of pipe at the various stages of the river.

The best practice, however, is to locate the pump at the base of the inside of a permanent water-tight well, or tower, whose bottom extends down a little below low water. A perforated suction pipe extends out into the river, and suitable connection is provided in the tower for flushing out this suction pipe with high-pressure water. To be safe, the pump and suction pipe must be in duplicate. Usually these pumps are low-service and pump to a sedimentation basin, from which the water gravitates through the filters to the clear reservoir, from which it is pumped by the high-service pumps into the service or into the distribution reservoir. To save cost, in some cases these towers may be built parallel to and just below the slope of the river bank.

Concrete Dams

The preferable construction in any important case is undoubtedly the masonry or concrete gravity dam. The base should be in width 70 per cent. or more of the height, and the down-stream toe should be 5 ft. or more below the surface of the solid rock against which it rests to prevent sliding. A narrow cut-off wall should extend under the up-stream toe down to practically impervious material. As most of the important failures of masonry dams have undoubtedly been due to undermining by erosion or to sliding and not to overturning, the greatest care should be taken to avoid these weaknesses. Much has been said about upward pressure, but the writer never thought this of much importance, because it is so easy to eliminate it by making porous and draining the entire base of the dam down stream from the cutoff wall and without diminishing the strength or adding to the expense. However, if the above proportion and precaution are adopted no further provision need be made, except to build it of the conventional shape, and of excellent material and workmanship.

Earth Dams

The next best dam is of earth. But to insure safety, requires ability, great care and the observance of several important elements of design. The first requisite is a cut-off trench deep enough below the natural surface and properly filled with water-tight material to prevent percolation under the dam.

The second requirement is that the whole of the dam material be deposited wet in thin layers (6 in.) and thoroughly compacted by heavy steam grooved roller, selecting the best material for the upstream portion and incorporating it with the material of the cut off trench. Third, the slopes must be protected from erosion. Fourth, an ample spillway, generally capable of discharging at least 250 cu. ft. per sec. per sq. mile of drainage area must be provided, and preferably constructed on the natural material at one end of the dam, and have its channel carried down to the stream.

The writer favors a completely unrestricted spillway rather than to place dependence on mechanically operated gates. The construction of earth dams cannot be too carefully inspected by men who know and observe the necessity of constant care.

Several important earth dams in the east and numerous ones in the west have been built by the hydraulic process. In some favorable conditions this method results in economy, but in the cases the writer has observed in the east, neither the economy nor the safety has been materially improved.

The hollow reinforced concrete dam has been developed within recent years, and at first seemed to possess much promise, but there have been so many failures and disappointments in the results without any material saving in cost that the plan has lost much of its popularity.

Choice of Pumps

The type of pump to adopt depends somewhat on the locality. Undoubtedly the most popular is the direct-connected electrical motor driven volute type of centrifugal pump. In fact, the wise manager will adopt this outfit even when he knows the total annual cost will be as great as with the best other installation he can make; and many people adopt it even when the annual cost is from ten to fifty percent greater. The popularity is due to quiet running, simplicity, small space, freedom from water-hammer, low repairs and the elimination of fuel and fire difficulties. The apparatus is more nearly standardized, the pumpage can be readily metered, the electrical current can also be readily measured, so that the entire mechanism is neat, scientific and good to look upon.

However, when the price of electricity is more than ¾ cts. per k. w. hour, the economy can be surpassed by steam, where fuel does not exceed $4.00 per ton.

When we get away from electricity we come to the direct-connected steam turbine driven centrifugal pump, which competes with the cross-compound condensing Corliss pumping engine, the latter being higher in duty but nearly double in cost of installation. To get reasonable duty the steam turbine plant must have a condenser producing 27 to 28 ins., while the fly-wheel steam engine produces a good duty with only 26 ins. vacuum. Under favorable conditions the steam turbine pump gives a duty of 110,000,000 while the steam engine pump produces 140,000,000 duty.

It is seldom that where any real attempt is made to get the best economy of operation a direct-acting compound condensing or even triple expansion pump is nowadays installed, but in the west American-made Deisel oil engines are frequently used. They will produce a horsepower on less than half a pound per hour of any kind of fuel in use. The engine can either be geared or belted to a reciprocating power pump or a centrifugal pump.

The producer gas pumping engine is not now so popular as it promised to be ten years ago. Probably that is because the producers are not readily adapted to different kinds of coal, and while the station duty is about as high as with the best steam plants under proper conditions, it is not easy to maintain these conditions.

In the boiler field no material advance has been made in the last ten or more years, except that automatic stokers, overloading and superheating have become more general.

Well Pumps

The air lift still affords the most popular method of pumping from artesian wells, where the water stands below suction distance. It is notoriously inefficient but easy to handle and lifts more water from a given well than any other method.

Where electricity is available at a reasonable price a vertical shaft motor driven multi-stage deep well turbine pump is the best and most economical installation and will produce an efficiency of over 50%, while the air lift gives less than 20%. These pumps can be so installed as to pump with the same motor the entire supply at once into the system under full waterworks pressure. The direct-acting deep well plunger pump is now seldom used in first-class practice.

Filters

Today the standard plan is mechanical filtration—generally of the open rectangular gravity type usually in half million or million gallon per day units. Each unit is provided with a simple rate controller, rate of flow and loss of head gauge. In the best plants these are recording gauges.

The strainer system of the filters are of various types, all of which have more or less merit. Probably the simplest and about as satisfactory as any, consists of a manifold and transverse pipes, 6 or 8 ins. apart with ¼ in. openings pointing downwards and spaced 6 or 8 ins. apart. On these iron pipes is laid graded gravel to a depth of say 18 ins. and thereon a layer of 2½ ft. to 3 ft. white silica sand between No. 15 and No. 30 mesh. The walls and bottom of the filter are of reinforced concrete preferably, but sometimes of iron or even wooden plank.

A wash water tank 20 or 30 ft. above the filters is desirable, and the washing system should be designed to wash at a rate of 15 to 20 gals. per sq. ft. per minute. At this rate air or mechanical agitation is unnecessary.

A sedimentation tank or reservoir holding not less than three hours and not necessarily more than 24 hours supply is essential. Into this the sulphate of alumina is fed at a uniform rate about as near proportional to the consumption of water as convenient. In some cases this basin has directly connected with the suction pipe a small compartment into which a portion of the coagulant is fed, with the idea of getting a better floc for the filters. Generally, the one large basin is all that is necessary to operate.

It has been found within the last ten years that the alum sulphate can be automatically fed at a uniform rate dry with far less difficulty than by making solution mixtures as heretofore.

Chlorine

In all first-class purification plants provision is made for sterilizing the filtered water by either liquid chlorine or by hypochlorite of calcium, the former being the most popular at the present time.

Some managers have the system designed so this chlorine will automatically feed in proportion to the consumption of water, but where there are attendants available, hand control will give just as satisfactory results, especially where it is fed into the clear water reservoir.

Lime or Soda

The complete treatment of a highly colored water often requires lime or soda ash to produce sufficient alkalinity to neutralize the sulphuric acid of the alum, but often times the color must be removed first by alum sulphate and the lime added later. Otherwise the color will be set and cannot be removed at all.

Laboratory

Every plant has its own particular water treatment, and therefore a neat laboratory forms an essential part of every filter plant. In it there is provision made for determining the number of bacteria, the presence of B. Coli, the alkalinity, turbidity and color—all simple tests that anyone can readily learn without previous technical education.

Supply Mains and Distribution System

For low pressure large conduits are now made of cast iron, reinforced concrete, steel, wood or terra cotta. Cast iron is the standard construction, but reinforced concrete, when made and laid according to the best modern practice, seems to be the most practicable for low pressures, say from 10 to 50 ft., because it does not corrode and maintains its carrying capacity indefinitely.

Steel pipe is used in the west on account of the expense of transporting cast iron. In the east it has not been extensively used for water conduits, and in some of the most important cases where it has, the results have not given perfect satisfaction. Too much dependence must be placed on the coating, and no one as yet has discovered a satisfactory coating.

Wooden pipe has its field, but the conservative engineer will only use it where any other kind would be prohibitive in price. A 24-in. wooden pipe has 2¾ times the capacity of a 16-in. cast iron pipe and costs about the same money in normal times, so the temptation to use the wooden pipe is great. If it must be used it is important that the quality of the wood be subject to rigid specifications. "Prime inspection" is none

too good a quality. It is also important that the pipe be laid under such conditions that it be always saturated by means of sufficient internal pressure. As the internal working pressure depends entirely on the distribution of the iron bands on the outside, it is important that these be thoroughly coated, so as to resist the corrosive effects of the soil in which the pipe is laid. If there is cinder or acid water, this kind of pipe should not be used.

No matter how well coated, cast iron pipe usually develops tubercles, which reduce the carrying capacity. The writer believes this condition to be more prevalent with soft than with hard waters, due to the presence of free carbonic acid in the former.

Pipe Flow Formula

Due to the presence of these tubercles, it is impossible to develop a pipe flow formula that can be counted on as correct except when the pipe is very new. One pipe will deteriorate 10 per cent and another 70 per cent. in discharging capacity in twenty years' use under various conditions.

The Chezy formula is generally used, but many engineers prefer the Williams-Hazens formula, believing the results to be more accurate.

The former is, simplified:

Q=c d 5/2 power h 1/2 power divided by l 1/2 power, in which Q=a unit of flow per unit of time, d=diameter of pipe, h=loss of head in friction, l=length of pipe, and c is a constant.

The Williams-Hazen formula is almost identical, but the exponents are sufficiently different to require logarithmic calculations in all cases. The authors have devised a special slide rule which makes the solution of the formula as easy as to use the common slide rule with the Chezy formula.

The writer believes that for cast iron pipe formula requirements are superfluous, for the reason that the flow is too much modified by the condition of the interior. A tuberculation amounting to only 3 or 4 per cent. by volume of pipe can reduce the flow more than 50 per cent.

Pipe Cleaning

Every up-to-date system of water works with cast iron pipe should possess pipe-cleaning apparatus. Frequent tests should be made by accurate pressure gages to determine the coefficient of flow, and if it is found materially less than normal the machine should be sent through the pipe. Pipes from 4 to 12 in. in diameter can be cleaned for about 10 cents per foot, and a very long, continuous line of pipe up to 24 in. in diameter can be cleaned for less than half that sum.

Street Piping

The engineer is obliged to fall short of ideal conditions in installing street piping. To install a perfectly adequate fire protection system would involve a constant pressure of 75 to 100 lbs. per square inch, at least ten hours' supply held in reserve high enough to produce that pressure, and mains large enough so that eight or ten 1¼-in. streams can be maintained under a nozzle pressure of 60 lbs. at any point of the system, while at the same time supplying the maximum consumption.

It is needless to say that there is not one water works in a hundred that reaches within gunshot of that ideal state, to accomplish which would be prohibitory in cost. Hence the public always finds little difficulty in pointing out the fire protection shortcomings of the water works.

The object is practically attained, however, by means of the elevated distributing reservoir or large standpipe, the fair-sized street pipes, the fire engines and the well-equipped paid fire departments.

Metering

Every important plant should be designed to include on the pumping or gravity mains either Venturi, orifice or pitot tube meters, and a sufficient number of these should be provided so as to enable a record to be kept of the distribution of flow into the important divisions of the system.

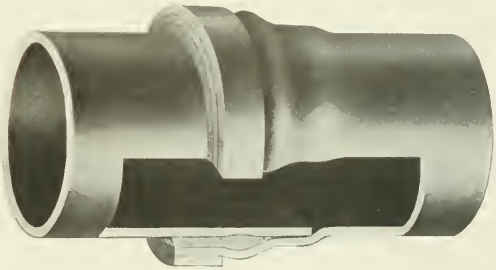
Recording Pressure Gages

For valuable information, as well as for the legal protection of water works owners, it is advisable to maintain one or more recording pressure gages on different parts of the distribution system.

The Use of "National" Matheson Joint Steel Water Mains

By F. N. Speller, Metallurgical Engineer, National Tube Co., Pittsburgh, Pa.

For about 30 years welded steel bell and spigot pipe has been used for water mains. For the past ten years most of this has been made with the expanded end known as the Matheson joint. Failures of the kind reported every week or so in the newspapers have so far been practically unheard of with this kind of pipe. This unbroken record of reliability is not affected by occasional leaks due to severe corrosion or electrolysis or collar leaks which occur also in cast iron or other pipe. Reliability in service is based on the large and uniform factor of safety especially against shock which obtains in this class of steel pipe. There are none of the hidden blow holes and other defects to be expected in cast metal. The foundation does not have to be so rigid. More power can



SECTION THROUGH JOINT OF "NATIONAL" MATHESON JOINT PIPE.

be safely employed in caulking and a much wider range of pressure can be safely carried in the same pipe compared with cast iron. Instances have been reported where this pipe has been permanently dinted and distorted by rock slides without leaking or interrupting service. For these reasons and considering the large saving in weight it is not surprising that Matheson joint steel has become so generally used in the mountain districts, said Mr. Speller in addressing the New England Water Works Association.

Each length of this pipe has a suddenly applied test pressure of 450 to 600 lbs. at the mill. This, together with the strain which is put on the weld, and material, when the bell is rolled out makes it almost a certainty that there will be no failures in service.

Carrying Capacity

Several tests have been run in service where cast iron and welded steel lines were conveniently located for this purpose, which proved the larger carrying capacity of the latter. This has been carefully determined on new pipe (4, 6 and 8 in.) in some elaborate tests under the supervision of the Underwriters' Laboratory, the results of which will be published in the near future. These tests indicate an increase in capacity of 20 per cent. in the steel over cast iron of the *same inside diameter*. As Matheson joint steel pipe is made to outside diameter and cast iron to inside diameter, the difference in favor of the steel on these nominal sizes is found to be 3 per cent to 4 per cent.

Durability

The service records covering the past 30 years also indicate less tuberculation on steel altho this trouble, like corrosion, varies so much with water conditions that it is difficult to make close comparisons. Durability is usually discussed in conjunction with strength and reliability in service when, as a matter of fact, they are separate problems which involve materials having widely different properties. Cast iron is necessarily made comparatively thick on account of the weakness of the metal and limitations involved in casting operations.

To take advantage of the lighter weight and greater strength of steel and at the same time increase the durability in service involves the use of a reliable protective coating. Much has been done along this line of late years, led by the demands of the oil and gas interests, where high pressure and consideration for safety have made welded steel pipe the standard.

Pipe Protection

Where conditions are very bad, as in tide water swamps, permanent protection has been obtained by boxing the pipe and filling in with 2 in. of well mixed concrete. While this has been proved satisfactory by 20 years' experience a cheaper and more flexible coating is usually all that is required.

Before any coating is decided upon, however, a careful survey of local conditions should be made to determine how much bad strata the pipe will pass thru. It usually turns out that only 5 or 10 per cent. of the system is exposed to conditions which might cause apprehension and such localities may be carefully protected without involving a considerable expense per foot over the whole line. However, it is safe to say that some protection should always be provided underground. This may be only a dip outside and inside in hot asphaltum of good quality. This acts as a good priming coat should it be thought advisable to add further protection. We advocate a wrapping of fabric saturated with a good quality asphalt pitch having a flow point of about 150 deg. F. Another layer may be applied, if necessary.

Application of Coating

Special machinery has been designed to apply this coating tightly and uniformly at the place of manufacture but if conditions warrant the coating may be applied in the field after cleaning and drying the line and applying a thin priming coat such as coal tar dissolved in benzol. The Standard Oil Company, of California, applies two layers of asphalt of high melting point to the cold pipe as soon as the priming coat is dry, which is covered spirally with a strip of burlap about 8 in. wide. Another thin coating should be applied to saturate and preserve the burlap. The writer has seen lines where the coatings so applied were ¼ in. thick on top and 5/16 in. underneath. These oil lines operate at 700 to 800 lbs. pressure. This would seem to be approaching the ideal system, where the pipe is strong and ductile enough to stand any reasonable amount of settlement or shock and where the coating is made of the material which experience has taught to be the best to withstand soil corrosion and electrolysis.

Inside corrosion of water mains has given comparatively little trouble; a properly applied dip has given all the protection required in the large majority of cases.

Refuse Collection and Disposal

Experience of Los Angeles with Cobwell Method of Garbage Disposal

The Pacific Reduction Co., of Los Angeles, Calif., has, for two years, been using the Cobwell system of garbage disposal and their experience with the method is summarized as follows by Howard Egleston, New Orleans, representative of the Cobwell system:

Lorin A. Handley, president of the Board of Public Work of Los Angeles, has written Mr. Egleston a letter, in which he says: "I do not hesitate to say this work is successful and satisfactory as a reduction method in every way—the most satisfactory I have ever known. Up to the present time we have never had a complaint registered by any citizen of Los Angeles."

The reducer, which is the essential feature, consists of a steam-jacketed, cylindrical steel chamber inclosing a rotary agitator operated by gears driven by motors. From five to six tons of garbage may be introduced into reducer. It is covered with cobolene, a form of naphtha or gasoline. Steam to a pressure of about 90 lbs. is admitted and the agitators are started, the reducers being tightly sealed. Vapors from the solvent and evaporating water pass through a pipe line to a condenser where the solvent is separated from the water, and returned to the reducer to be used over and over. The water is vaporized at a lower temperature when evaporated with the solvent, having a lower boiling point than otherwise would be required. This process completely dehydrates the garbage. A large amount of grease is liberated and is contained in the solvent. The mass is drained to a still, where the solvent is evaporated from the grease. By running more solvent through the mass the last vestige of grease can be recovered. The product free from grease and solvent is automatically emptied from the reducer to a conveyor, which moves it to a warehouse, where it is screened, ground and sacked, in appearance resembling ground coffee.

The Los Angeles plant gets about 630 pounds of the product from a ton of garbage. This is shown by analysis to contain: Nitrogen, 3.05 per cent; phosphoric acid, 1.96; potash, 1.22; crude fiber, 16.55; carbohydrates, 45.75; grease, 1.71 per cent; ammonia, about 3 per cent. The product is an excellent fertilizer. It also can be used as stock feed, and when soaked with water can be fed to hogs and other animals. The grease, of which each ton contains about 70 pounds, is valuable.

The reducers in Los Angeles not only dispose of garbage but of dead animals, and the product from carcasses is even more valuable than from the garbage, bringing last year $55 a ton as compared with $11 a ton for garbage, but of much greater value at this time.

In the Los Angeles plant about 660 pounds of steam are required for one charge consisting of from five to six tons of garbage.

The Los Angeles plant spends about $8,000 for water a year but in New Orleans the cost will be much less.

Los Angeles does not operate its plant. Its contract is that the Pacific Reduction Company pay 51 cents a ton for garbage delivered and dispose of private waste and dead animals at a fixed charge.

Mr. Egleston states that the high cost of gasoline will not affect the cost of operation to any appreciable extent because the gasoline or naptha used is condensed and used again and there is practically no waste.

Garbage Disposal by Dumping, Sanitary Fill, Burial or Plowing

Among the methods of garbage disposal in common use are: dumping, sanitary fill, burial and plowing. These methods are within the reach of small communities and such communities should note what the Springfield Bureau of Municipal Research, of Springfield, Mass., has to say relative to these methods.

Dumping on Land

The method of disposal of garbage by dumping on land, by dumping for sanitary fill and by burial or plowing into the soil are similar in many respects. Dumping on land, however, means simply the depositing of garbage on the surface of the ground without care to see that it is properly covered. Many cities dispose of their garbage in this way.

This method is most objectionable. It is difficult to find sufficient land suitable for dumps, especially when large quantities of garbage are produced. Offensive odors from fermenting and decomposing matter create a nuisance. When located in the outskirts of the city so that the dumps will not be offensive to citizens, the cost of hauling is increased to a marked extent. Garbage dumps are unattractive and injure property valuations of adjacent areas.

Disposal by Sanitary Fill

By this is meant the depositing of garbage in excavations or on low ground that it is desired to reclaim. It is distinguished from dumping on land, in that the garbage thus dumped is mixed and covered with earth, ashes or other material, and in sufficient amount to prevent its causing a nuisance and yet not in sufficient quantities to prevent oxidation and disintegration.

The method has been used successfully by several cities, among them Seattle, Davenport, Ia., and New Orleans.

This method requires that garbage be combined with ashes and other refuse and thus makes possible the combined collection of all refuse. Where garbage is properly mixed with other material the method is free from nuisance. It is economical in undertaking as well as in operation. The initial cost may be nothing if private parties own the area to be filled since they are glad to have the value of their land thus increased. If the city purchases the land the initial cost will be the amount paid for the property, usually small because of the property being of little value. This payment is made up, however, many times over in the value of the land reclaimed. Davenport is improving its river front by this means. New Orleans is laying out the areas reclaimed for parks and playgrounds.

The cost of collection is less where this method is employed due to the possibility of the combined collection of garbage, ashes and rubbish. The cost was given by Davenport as 50 cents per ton. Seattle reported eleven fills cared for by eleven laborers, disposing of approximately 350 tons, "while one incinerator with about an equal pay-roll will only dispose of 60 to 75 tons per day, running 24 hours. A fill increased the value of property, while the refuse from one incinerator has to be hauled away at an added cost."

Burial.

By this method garbage is buried in trenches 5 ft. by 6 ft. or smaller. It is usually covered with the earth thrown up in digging the adjoining trench. Garbage thus disposed of will be taken up by the soil and usually in a period of three years will have become a part of the humus.

Burial of garbage is sanitary and should cause no nuisance where properly carried on. It was employed temporarily by Springfield, Mass., in 1916, but was objected to so strenuously on the part of property owners and residents that it was shortly discontinued.

For a large city such a method is unsatisfactory because of the large amount of land that is necessary, averaging from 1½ to 3 acres a year per daily ton, because of the long haul that is necessary to reach areas available for such disposal and because of the fact that no income can be derived from this method of disposal.

Plowing into Soil

This method is very similar to burial, the exception being that the garbage is covered with earth by means of the plow instead of being placed in trenches. As in the case of burial, garbage can be disposed of by this means in a sanitary manner, but with greater difficulty. However, the amount of land required, the usual long haul, and the lack of income do not make it desirable for a large city.

DRAINAGE AND IRRIGATION

The Unprecedentedly Good Outlook for Irrigation in 1918

By F. W. Park, 1625 Monadnock Block, Chicago, Ill.

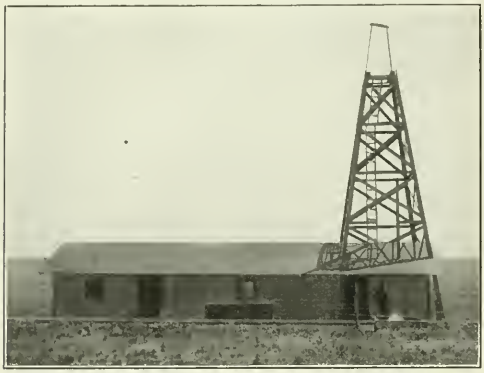
(This article is an "eye-opener." To the man who thinks of irrigation only in connection with "the country God forgot," this article will be a revelation. All those interested in agricultural production, especially in regions contiguous to cities, should give this article a careful reading.—Editor.)

Both God and the Kaiser have contributed to the awakening that is certain to make this year the greatest in the irrigation growth of the country.

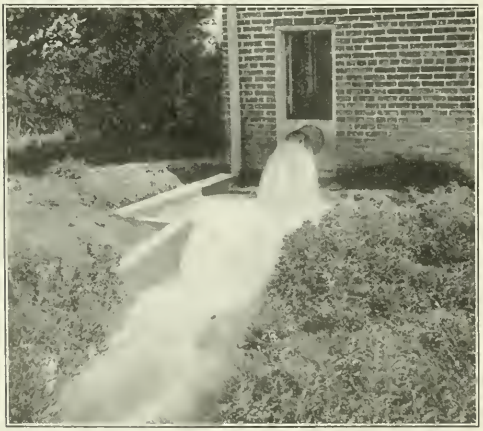
In the Great Plains where they produce a full crop only about one year in ten without irrigation the development of irrigation travels in cycles: The year following one of abundant rainfall, hope mounts high in the human breast and profits are spent in automobiles instead of irrigation pumping equipment. The year 1916 was a fruitful one in the Great Plains and every one of the faithful in Kansas advertised her bumper wheat crop. In 1917 things were different, with a drouth over large parts of Kansas, Oklahoma and in 105 counties of Texas. Thousands of farmers of small means in Texas have been compelled to sell their live stock and sacrifice their homes, and those with sufficient finances to hold on, have suddenly displayed keen interest in the Panhandle country, where in the area marked in our boyhood geographies "The Great American Desert," they are now producing enormous crops of alfalfa, grain sorghums and thorough-bred cattle and hogs through irrigation by pumping. Kansas also has recovered from her ecstacy and is now casting her weather eye in the direction of Garden City, where the United States Sugar & Land Co., are no longer trusting in Providence to supply the water, but are pumping from deep wells to irrigate tens of thousands of acres of sugar beets, kafir corn, milo, maize and alfalfa; the alfalfa yielding five cuttings to the acre each season, averaging 1¼ to 1½ tons to the cutting and converted into alfalfa meal and beef and pork all on their own ranches.

Great Field for Irrigation Close to Good Markets.

When the Kaiser shouted "Deutschland Uber Alles" and concluded that he could get away with it, the arid West was assured of high prices by the war and naturally developed her irrigation as the only means of increasing her agricultural production. But it's a difficult thing for the average American to conceive that agriculture under intensive methods in areas close to good markets offers far greater possibilities in the humid East than any place in the far West. Because crops cannot be produced in the arid regions without irrigation and some kind of a crop can be grown in most humid areas without artificial watering, the average man imagines that one who suggests irrigation in a region of large average rainfall must be a fit subject for a lunatic asylum. Besides, his grandfather produced crops without irrigation and then they have floods in which crops are actually drowned out, and why should one do anything different under these circumstances?



IRRIGATION PUMP HOUSE IN TEXAS. WELL 20 INS. IN DIAMETER, 140 FT. DEEP. EQUIPPED WITH AMERICAN 3-STAGE, 18 IN., DEEP WELL CENTRIFUGAL PUMP DELIVERING 1,000 G. P. M.



VIEW OF FRIZZELL'S PUMPING PLANT AT FORT LARNED RANCH, KANS.

The great irrigation development in the United States will be governed by convenience to good markets and will be in the semi-arid and humid regions and not in the limited arid areas capable of being irrigated in the far West. Irrigation will far more than double agricultural production in the Central and Eastern states, but its development must be accomplished through specialization first in favored areas and by the optical demonstration of the work of the large number of experts now located throughout the humid regions who are producing ten, twenty, and in many instances one hundred times as much by supplemental irrigation as the average farmer does without artificial watering. In a few years every farmer in a large part of the Great Plains will be educated to the fact that supplemental irrigation is his only reliable crop insurance and he must have his irrigation pumping plant. Garden truck grown under overhead spray irrigation produces so much greater in quantity and so much better in quality, that within a few years it will be impossible to dispose of the unirrigated product in the best markets. Already hundreds of great irrigated truck gardening enterprises are located close to Northern cities.

IRRIGATION PUMPING STATION AT PLAINVIEW, TEXAS. PUMP IS AMERICAN 24 IN., 2-STAGE, DEEP WELL CENTRIFUGAL BELTED TO OIL ENGINE, DELIVERING 1,500 G. P. M. AGAINST TOTAL HEAD OF 75 FT.

Irrigation in Regions of Great Rainfall.

Failure to recognize the importance of irrigation in areas of greatest rainfall is due to not understanding the following fundamental requirements: From 200 lbs. to 1,200 lbs. of water are required to produce every pound of solid matter in plant life, with a minimum of 400 lbs. for most plants. Plant growth stops immediately the ground becomes saturated by excess water, but also stops just as quickly when the roots no longer receive proper moisture. One inch of water is required for most garden truck in each ten day period during the growing season. Nearly all field crops require at least 1 in. of water every 20 days during the period of growth, and there are few crops that will produce a full harvest whenever less than 1 in. of rain falls within a 30 day period during the growing season. Study a rainfall chart of the United States and scarcely an area will be found even in regions of greatest average rainfall in which at least one 30 day period does not occur during the season in which less than 1 in. of rain falls, which should

indicate the absolute futility of obtaining maximum production in any locality without irrigation. The proof that this is not theoretical, but represents actual conditions, is demonstrated by what is now being accomplished in extensive widely separated areas and by hundreds of specialists in scientific agriculture throughout the Eastern and Central states.

Specific Examples of Profitable Irrigation in Humid Regions

Most of the costal plain of Texas has a comparatively large but uncertain rainfall. Truck gardening in this area without irrigation is not even a fair gambler's chance. Last year hundreds of farmers in this region produced from $600 to $800 per acre gross on every acre under irrigation.

POTATO CROP ON IRRIGATED LAND AT CARBONDALE, COLO., YIELDING AS HIGH AS 600 BUSHELS PER ACRE.

TYPICAL OVERHEAD IRRIGATION SYSTEM DESIGNED BY ENGINEERS, MUCH USED IN INTENSIVE AGRICULTURE NEAR LARGE CITIES.

Florida

Down at Bartow, Florida, J. R. Davis has been specializing in winter truck gardening for many years. He farms about 700 acres and notwithstanding that he is located in an area in which the average annual rainfall is about 60 in. his success lies in irrigation, and over 100 acres of his farm is equipped with an overhead spray irrigation system. For a half dozen years before the present high war prices his annual net profits exceeded $25,000.

Massachusetts

The Connecticut Valley Onion Co., South Deerfield, Mass., are the largest growers of onions in New England. Some of their farms are equipped with overhead irrigation while others are not provided with artificial watering. The average production of the irrigated farms is over 1,000 bushels of onions per acre, and the unirrigated farms less than one-fourth this quantity.

Michigan

At Three Rivers, Mich., where the average annual rainfall equals any other area in this latitude in the Eastern states, the R. M. Kellogg Co., have a 225 acre strawberry plantation, the largest in the world. Over 130 acres of this farm are under overhead irrigation, and the average annual gross production of the irrigated area is about $2,000 per acre.

New Jersey.

New Jersey receives about the average annual rainfall of most of the central Eastern states. Located at Bridgeton, N. J., is the Seabrook Farms Co., specialists in truck gardening. This company owns about 600 acres, part of which is under development, but have about 180 acres under overhead irrigation. For the year 1916, before the present high prices, the average gross sales of the entire acreage under irrigation was about $2,000 per acre, while certain acres produced over $3,450.

Arkansas.

Stuttgart, Ark., is the county seat of Arkansas county, one of the greatest rice growing areas in the United States. The rice must be kept flooded from the time it attains a growth of from 3 to 4 in. until about two weeks before harvest. Raw prairie land can be bought in this area at about $35 per acre. A well and pumping plant capable of irrigating 160 acres of this land will cost an average of about $6,000. Dozens of farmers around Stuttgart during 1917 produced over 100 bushels of rice to the acre on their entire acreage, which was sold to local dealers at from $2.03 to $2.14 per bushel, paying the entire cost of farm, pumping equipment, tools and labor expenses in a single year and netting them profits of 40 to 50 per cent on their investments besides. A conservative estimate of the

ONE OF TWO IRRIGATION PUMPING PLANTS IRRIGATING 240 ACRES NEAR LARNED, KANS.

value of the new irrigation pumping equipment that will go into this county during 1918 would be $1,000,000.

Colorado

High up in the mountains of Colorado, at Carbondale, Sweet Brothers, the potato kings, are located. They practice a four-year scientific crop rotation and irrigate. One year of the four is devoted to a wheat crop, producing an average of 65 bushels to the acre, weighing 62 lbs. to 64 lbs. to the bushel, but this is not considered a money crop. Another year oats are grown, producing 100 bushels on the average to the acre and weighing 42 to 45 lbs. to the bushel, but this also is not a money crop,—just a part of the rotation. The third year alfalfa is grown, yielding an average of five to six tons to the acre and this is considered a fair money earner. The fourth year in the rotation is the big money crop, produced by potatoes, of which about 125 acres are grown, averaging over 500 bushels to the acre, and of the finest quality, most uniform size, and commanding the highest market price of any in the world. Dr. Appell, the foremost potato authority of Germany, visiting this country before the war, declared he had never seen such potatoes and this, despite Germanys' boasted supremacy in potato raising.

Conclusion

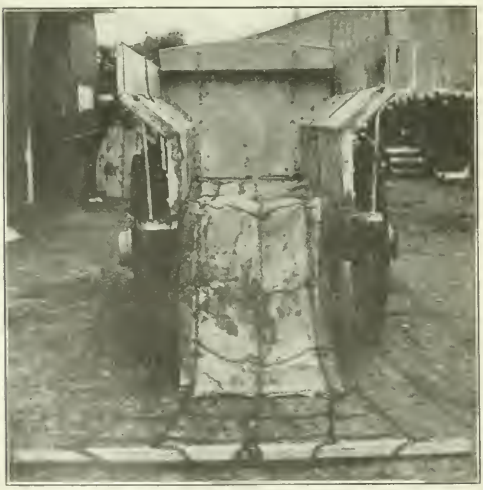
To one who has watched closely the development of irrigation, the question arises: Had Germany been able to copy the methods of the leaders in irrigation of this country as closely as she imitated our inventions of warfare, would she not have been able to win the war? Similarly, if the entire farm population of the United States were persuing the methods of these same irrigation leaders, instead of the ridiculous improved farm average production of about $20 an acre, that we maintained before the war, we would be now growing enough food to feed the entire world.

From Workers in Field and Office

Garbage Wagons in Use in Ottawa, Ontario

Editor of Municipal Engineering:

Sir—A rear view of the garbage collection wagon in use in the city of Ottawa, Ontario, is here shown. It is of 6 cu. yds. level capacity, having a removable tail board and upper board on one side on hinges so that it may be dropped down for loading up to that level. The view shows the roll canvas cover on the upper left-hand side of the wagon box which



REAR VIEW GARBAGE COLLECTION WAGON USED BY OTTAWA, ONTARIO.

goes over the load when filled. The unloading device consists of five chains fastened to the rear end of the floor only and when in position for loading lies along the floor and up to the front to a hardwood cross piece to which they are joined in one ring. The cross chains are placed every 18 ins. and the canvas is fastened with clips to lie along the bottom on top of the chains. When the wagon is loaded and reaches the incinerator or dump the ring on the cross bar is attached to a cable and a team of horses on the dump or a motor at the incinerator rolls the load out over the back when this unloading device is then in the position shown in the accompanying view.

From this it will be seen that the load is all dumped behind the rear wheels and the unloading device is on top of the load just dumped so that it can be quickly placed back in position on the floor of the box and the back of the wagon replaced.

This unloading device which has been used also in Buffalo and Rochester for the unloading of refuse only is used here for the unloading of all material including ashes and garbage. I have not seen the canvas cover used in any other place but have found it useful, especially in the unloading of ashes. By this unloading device a type of wagon such as we have here can be used or even an ordinary box, which, however, should be strongly braced on the outside at it will be noticed we have done in these wagons, with ¾ in. iron braces. If this be not done there is a tendency for the box to drop while the load is being rolled out. The time required to unload will vary from one to three minutes, the shorter period being for favorable circumstances where the wagon can be backed up to the incinerator unloaded by a cable attached to a motor.

The horses required to pull these wagons, according to our local specifications, must weigh at least 1,500 lbs. as we have found this weight is necessary in the unloading of ashes in the winter time.

I adopted this type of wagon and this unloading device after I had investigated the different types of back dump and under dump wagons in the various cities in Canada and the Northern States. Most of these wagons I found were of relatively the same capacity, besides being too heavy for their capacity. The wagon box is made up of 1½ in. material with the exception of the bottom which is 2 in. material having 4 cross braces. The total weight of the wagon is 2,800 lbs.

Very truly yours,

Andrew F. Macallum,

Commissioner of Works.

Ottawa, Ontario.

Unique Method of Building Reinforced Concrete Infiltration Gallery in Los Angeles River

The Editor of MUNICIPAL ENGINEERING:

Sir—

A novel method of transporting and lowering concrete pipe into a trench in the Los Angeles River is being used by the city of Los Angeles. The concrete pipe is built in sections of such a form and weight as to make it very difficult to handle them. A special set of tongs has been built, by an employe of the city, for this purpose. These tongs have two downward projecting arms that grasp the outer surface of the concrete section when the chain fastened to a crane pulls up on the tongs. The tongs are placed exactly in the center of the section.

After the section has been lowered into the trench the chain connected to the tongs is loosened and the tong is opened and locked in this position. It is then raised and fastened to another section.

The sections after being lowered into the trench are set by means of a frame mounted on four flanged wheels. This frame runs along the top of the sections that have been set and by means of two clips which fasten onto the steel rods extending from the top of the concrete sections the hoist supported by the frame raises and lowers the section until it is in the position desired. The frame is then moved up to the edge of the section just set, ready to repeat the operation on the next section when it is lowered.

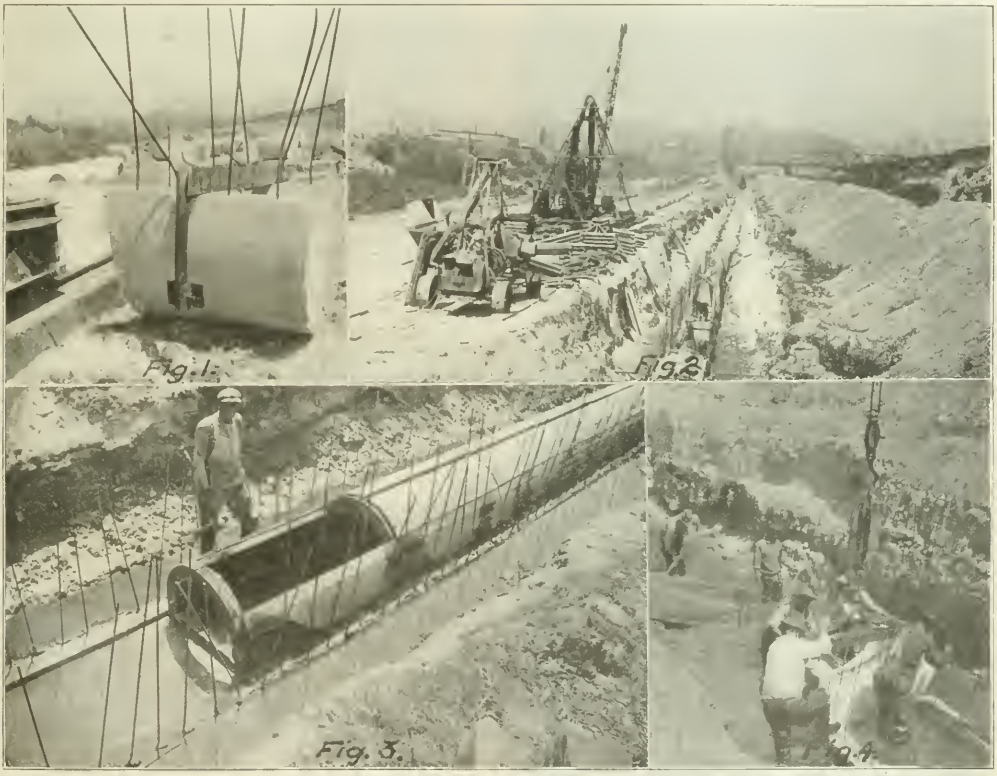
These sections are to be used as a filtration gallery. This is an unusual method of building a gallery. The top section of this concrete gallery or tunnel will be built in one continuous section 8,000 ft. long.

The forms for building the top section are unique and of special design. The inside forms are supported by ribs which interlap each other at the top and are supported by a "V"-shaped chair, which in turn rests on the bottom of the concrete conduit. A stream of water is constantly running through the conduit, and the chair is so constructed as not to obstruct the water. An accompanying photograph shows how the ribs interlap at the top and also shows how they are supported by the chair. When the top section is hard, the chair is knocked out, which permits the ribs to fall out, making it easy to remove the inside forms. In the photograph the chair is supporting the ribs. The lower section of the gallery is running nearly level full of water. The steel rods are bent around the forms, reinforcing the top section and bonding it to the lower section.

Very truly yours,

C. W. GEIGER.

Los Angeles, Cal.



VIEWS SHOWING CONSTRUCTION OF CONCRETE INFILTRATION GALLERY IN BED OF LOS ANGELES RIVER. FIG. 1—TONGS USED IN LOWERING SECTIONS OF INVERT. FIG. 2—GENERAL VIEW OF CONSTRUCTION OPERATIONS SHOWING STEAM SHOVELS IN DISTANCE, SECTIONS OF INVERT ALONG TRENCH, THE TRAVELING CRANE AND CONCRETE MIXER. FIG. 3—FORMS FOR ARCH SUPPORTED ON CHAIR RESTING ON COMPLETED INVERT. FIG. 4—LOWERING SECTION OF INVERT INTO POSITION.

New Combination Flushing-Sprinkling-Refuse Collection Equipment of the New York Department of Street Cleaning

Editor of Municipal Engineering:

Sir—The accompanying photographs show a combination street sprinkling or flushing machine and refuse collection vehicle, which consists of a 6½ ton Mack truck equipped for summer use as a flushing machine and for winter use as a refuse collection vehicle.

The flushing equipment includes a 1,500 gal. tank, a twin volute or two-stage centrifugal pump mounted in such a way

COMBINATION FULSHING-SPRINKLING-REFUSE COLLECTION MOTOR TRUCK OF TYPE OPERATED BY NEW YORK DEPARTMENT OF STREET CLEANING.

that it is driven directly from the main shaft of the truck. This pump supplies either two sprinkling nozzles or four flushing nozzles, with water at a pressure of approximately 40 lbs. All nozzles are under the control of the driver from the seat.

The machine will clean in excess of 100,000 sq. yds. of pavement in eight hours and requires but one man to operate it. The total weight, when filled with water, is approximately 28,000 lbs.

All parts of the flushing equipment are so constructed that they may be removed from the truck in the space of a few hours and replaced by a special power dumping body, at the end of the flushing season, or vice versa, at the beginning of the flushing season.

The refuse collection body is of a type known as Read body, provided with removable sides, to allow easy loading, and a covered top to reduce the dust nuisance. Its capacity is 10 cubic yds,, with provision for one cubic yard of water, so that it may be used on garbage collection and dripping of liquid from the load prevented.

The special advantage of this combination type is easy interchangeability from flushing to collection. This meets the peak load needs of northern cities by providing extra cleaning equipment in the summer, when it is most needed, and extra refuse collection equipment at a time when flushing cannot be performed, and when the production of ashes is so great that extra equipment must be made available.

Very truly yours,
J. T. Fetherston, Commissioner,
New York, N. Y. Department of Street Cleaning.

Motor Truck Service is All-Important

To the Editor Municipal Engineering:

Sir—With reference to the operation and cost of auto trucks used by the Bureau of Highways of the Borough of Queens of the City of New York, we did keep cost when we first purchased these trucks, but found from experience that keeping cost on this particular equipment only afforded us general information for the reason that there was a continual fluctuation. The cost information would only be necessary for the purchase of new equipment, and we found that the most important point, from our point of view, is that of service, regardless of the truck's value itself.

Very truly yours,
C. H. Shepheard,
Long Island City, N. Y. Assistant Engineer.

Flying Squadron of Laborers on Pennsylvania Highway Work

Editor Municipal Engineering:

Sir—Our experience with flying squadrons of laborers is very limited, but we are satisfied that the same can be worked successfully. We have just purchased nine five-ton trucks and are having them equipped with snow plows and are going to send these out with a few laborers in an attempt to keep the main highways open during the winter, particularly the Lincoln Highway, which is now used to take all the new trucks and pleasure cars east. We have also leased quarries and installed crushers throughout the State and are going to get out stone for this year and are going to try having squadrons move from place to place in the trucks and live in tents, particularly on maintenance work, as I feel it would be a great mistake to allow our roads already built to deteriorate. We are also laying out a plan for new roads whereby local material can be secured, which will eventually work into a system and we expect to do considerable work this year providing we can get prices which will justify the work.

Very truly yours,
J. D. O'Neil,
Harrisburg, Pa. State Highway Commissioner.

Good Record Made With Elevating Grader on Irrigation Reservoir Construction

Editor of Municipal Engineering:

Sir—The accompanying view shows a section of dam I built on contract and on which I made a record with a Western Elevating Grader and Western dump wagons which has caused

considerable comment. In the month of August, 1917, we put in 19,129 cu. yds. of fill in 26 days. My foreman, W. R. Burck, is an artist at dirt moving and by keeping the 15 wagons constantly "turning," and because of little trouble we had, we made the creditable record mentioned.

VIEW OF GRADING OUTFIT ON LEAN SPRINGS IRRIGATION RESERVOIR CONSTRUCTION IN TEXAS.

The job on which this record was made is the Lean Springs reservoir for irrigation purposes. The work comprises the placing of 90,000 cu. yds. of fill and 15,000 sq. yds. of riprap. The reservoir will hold about 7,000 acre-feet of water and is fed by the largest spring in the Southwest.

The elevating grader used is new, and outside of belt trouble we did not have any delays. Constantly keeping watch for trouble that might arise, keeping all wagons constantly on the move and plenty of oil on the bearings will do much to make big estimates for contractors on work like this.

We used 3 up wagons, chiefly, on about a 1,000 ft. average haul and loaded the wagons to their full capacity.

The record run mentioned was made on the lower lifts of the dam in which we put in 4 ft. lifts and bordered up and irrigated. A feature we find to work well is to put on a lift and put 4 in. of gravel on the front slope which is 3 to 1. We can thus carry up the riprap as the work progresses and in this way finish all parts of the work at about the same time.

Very truly yours,

Ft. Stockton, Texas. W. E. HAMILTON, Contractor.

DIGEST OF THE ESSENTIAL NEWS

New Jersey Plans to Spend $5,000,000 on Highways This Year

Major General George M. Goethals, supervising engineer of the New Jersey State Highway System, on which $15,000,000 is to be spent, has filed a report with the State Highway Commission which has been embodied in a communication to Governor Edge. The proposed system, based upon a direct State tax, has withstood legal and political attacks upon it and may now be considered a sure thing.

The commission shows that the tax will make available $3,165,000 for the first year's work, in addition to which there will be about $2,000,000 from the Motor Vehicle Department for repair work in the various counties.

General Goethals recites the work done in mapping out the fifteen routes and their alternatives and the various estimates and office work done. Scarcity of engineers for the surveys has retarded the work. This shortage is due to the war. Despite this handicap the entire system will be mapped and its costs estimated in detail—this work is about completed.

No work will be done until about April 1, 1918, or as soon as the winter breaks up. However, construction work has been started on roads leading to Camp Dix at Wrightstown and to Camp Merritt at Tenafly. At Camp Dix a four mile stretch was built with labor from the Rahway Reformatory, and this cost $90,000.

Cleveland Will Spend $5,000,000 for Comprehensive Sewer Construction

A vote was taken in Cleveland on November 6, 1917, in connection with authority to issue $3,000,000 worth of bonds for sewer purposes, and passed by the necessary two-thirds majority. Relative to the expenditure of these funds Robert Hoffman, commissioner and chief engineer of the Department of Public Service, writes as follows :

This amount of money is to be used in paying the city's portion of the cost of sewer construction which is expected to take place during the next four or five years. The property owners' contribution towards the expense of paying for the sewer construction is in addition to the $3,000,000 bond issue, so that the total amount of work will probably amount to at least $5,000,000 in connection with this program.

The list of work, and the amount of the same which may be placed under contract this coming season, has not yet been definitely determined. Considerable engineering work is still required in the design and planning of main sewers.

The program for the year 1918 will quite likely be decided by January 15. It has been found desirable in this city to start on a fairly large, comprehensive plan of sewer construction, for the reason that a number of the old sewers, built forty or fifty years ago, will require reconstruction because they are becoming physically unfit or they are proving inadequate in size and depth to accommodate districts which they serve. The rapid growth of the city is also demanding large expenditures for sewers in order to provide adequate sewer facilities in the newer portions of the city.

It has seemed impractical to make any proper progress in connection with sewer work under the method which has formerly existed, in supplying only a limited amount of funds each year for sewer construction, as such sum has not in recent years proved adequate properly to provide for the projected necessary work.

With the sum available under authority of the new proposed bond issue, the department will be able to lay out a comprehensive, practical program extending over several years, since the assurance is had that the financing of the work will be possible as soon as plans are prepared.

Illinois State Highway Plans Gain Great Momentum

Illinois' drive for the five federal highways was probably the greatest ever made in a like period in the history of any state. It presages, those in direct charge of the movement believe, an overwhelming victory for the Illinois $60,000,000 road system to be voted on this year.

As a direct result of the work done throughout the state, public interest has increased in favor of the five fed-

eral highways now pending in Illinois. Clark, Effingham and Bond counties, located along the national old trail road, have voted county bond issues to secure their share of the federal and state aid to build this old, historic highway. Menard, Mason and Sangamon have voted county bond issues to build the Peoria-Springfield and the Springfield and St. Louis roads. Just recently Macoupin county, by a vote of 2,200 majority, decided to issue bonds to build their share of the road from Springfield to St. Louis.

On Oct. 23, Lake County voted $500,000 and on Nov. 6, Cook County authorized a $1,000,000 county bond issue to complete Sheridan road to the Wisconsin state line, and a secondary road to give relief to the traffic between Chicago and the Great Lakes Naval Training Station, as well as Fort Sheridan.

Winnebago County has voted bonds in favor of improving Grant highway from the City of Rockford to the east county line, and it is expected that Boone County will vote on a $400,000 bond issue this winter to improve this highway through Boone County. Of the twelve counties located along the five federal highways, who were required to vote county bond issues, only one voting so far, has lost, and that was in Fayette where the issue was defeated by less than 200.

It is understood they are already planning to resubmit the matter to the voters of that county. Cumberland and Madison counties are the only other counties remaining to vote, and it is expected that the bond issue will be authorized by the people of these enterprising communities.

Review of Bids Submitted on California State Highway Construction

A review of the bids submitted on California State highway construction in 1917 shows that, omitting one contract calling for re-surfacing only, 133 bids were received from 55 different contracting firms on 36 different pieces of work, says Western Engineering. On one contract bids were received twice, and rejected both times. The largest number of bidders on any one contract was nine, for grading the highway in Santa Barbara county between Las Cruces and Gaviota pass. On several contracts only one bid was received. In all, 32 contracts, covering 261.36 miles of highway, were awarded. Eight of these contracts, covering 73.7 miles of highway, were for grading, culverts, and similar work, and did not include paving; 4 contracts, covering 26.5 miles of highway, were for "finishing-grading" and paving, where the rough grading had been done before, while 20 contracts, covering 159.16 miles of highway, included both grading and paving. The total contract price was $2,302,740.23. The cost of materials furnished by the state will be approximately $1,250,000, making a total of over $3,500,000. To this amount should be added the cost of asphaltic surfacing for the concrete pavement, the State Highway Commission's overhead, and the cost of right-of-way and some large bridges. The total cost of this work will probably be between $4,000,000 and $4,500,000.

Bids Compared with Engineers' Estimates of Cost

A comparison between the engineer's estimate and the bids is of interest. For the first eight contracts, which were awarded in May, the figure named by the lowest bidder was in each case below the engineers' estimate and 15 were for more than the estimate. For the entire season, the sum of the bidding prices is $21,868.60 more than the engineers' estimate. This does not include jobs on which all bids were rejected.

Excavation

Classification of excavation to have been practically abandoned by the State Highway Commission engineers. On only one contract does any other grading item than excavation without classification appear. In this case there is an item of borrow excavation, presumably hauled for a considerable distance, taking the price named by the low bidder, $0.80 per cubi yard, as a criterion. Excavation without classification is a item of all of the 32 contracts awarded. The lowest pric was $0.39, the highest $1.05, and the average $0.704 per cubi yard.

Concrete

Concrete in culverts and monuments, the State furnishin all materials, is an item in 21 contracts. There is a wide rang in prices, the lowest being $6, the highest $22, and the averag $12.34 per cu. yd. On 8 contracts, the State furnished onl the cement. The lowest price is $12, the highest $17.50, an the average $14.94 per cubic yard.

Concrete in pavement, the State furnishing all materials, i an item in 22 contracts. The lowest price is $3.09, the highes $6, and the average $4.19 per cu. yd. On 3 contracts the Stat furnished only the cement. The average price is $6.43 pe cubic yard.

Miscellaneous Bidding Prices

Other bidding prices are as follows: Concrete in retainin walls, the State furnishing only the cement, is an item in contracts. The average price is $13.33 per cu. yd. Dry-rubbl masonry retaining-walls are an item in 4 contracts. The aver age price is $6 per cu. yd. Ordinary rubble-masonry is a item in 1 contract at $7 per cu. yd. Guard-rail figured at fron $0.40 to $0.50 per foot. Laying corrugated metal pipe is a able that average figures would mean little or nothing.
item in most of the contracts, but the prices quoted are so var

Trend of Prices for 2½ Years

A study has been made of the trend of bidding prices o this work for the past 2½ years. Figures have been compile covering low bids on contracts awarded between Dec. 14, 191 and July 26, 1915.

Excavation without classification was an item in 26 cor tracts, the lowest price being $0.30, the highest $0.70, and th average $0.50 per cu. yd. Concrete in culverts and monument the State furnishing all materials, was an item in 19 cor tracts. The lowest price was $6, the highest $15, and the aver age $10.10 per cu. yd. On 9 contracts, where the State fu nished only cement, the lowest price was $7.50, the highes $16, and the average $11.05 per cu. yd. Concrete in pavemen the State furnishing all materials, was an item in 15 contract The lowest price was $2.20, the highest $4.25, and the averag $2.90 per cu. yd. On 5 contracts, where the State furnished o ly cement, the lowest price was $3.49, the highest $6.15, an the average $4.41 per cubic yard.

In view of the above facts, it may safely be stated that th labor-cost of highway construction has increased at least 40% during the past two and one-half years. Fortunately for th general public, the increase in the cost of materials, while i has been large, has not been so large as the increase in th cost of labor.

Motor Freight Highways Will Aid in Solution of Transportation Problem

In congested localities private freight shipments are bein seriously held up to the detriment of practically every lin of manufacturing and general business. The situation is s serious that railroads in nearly every section of the countr are begging for relief by outside means of transportation, an in one case the officials of one of our great systems of ral roads have even made the suggestion that all passenger serv ice, with the exception of parts of the roads which exclusivel serve isolated sections, be annulled, thereby doing away wit and turning over to competitive lines all through passenge business between Boston, New York, Philadelphia, Baltimor and Washington and all western points on that company' system. The object is to convert the entire trackage to th carrying of freight, says S. M. Williams of Lima, Ohio.

Motor Freight Highways Offer a Solution.

One of two solutions towards assisting the railroads in handling the enormous amount of freight follows:

The utilization of the highways of the United States for the delivery of freight to and from congested terminal cities. Our highway systems, as they are already laid out, are elaborate, and reach every section of the country outside our large cities, and roads from every direction are running into these cities. Many of these roads have been improved, but they have not been built for the unusual strain that will be placed on them if large numbers of heavy motor trucks are started out over them on regular routes and runs such as would be necessary in handling intercity freight business. Heavier foundations and higher types of roads than those generally constructed in the past will be absolutely necessary if our roads are to be used for the transportation of large quantities of freight.

Motor Truck Traffic Has Increased at Enormous Rate.

Already motor truck traffic in the vicinity of our principal cities has increased at such an enormous rate, even within the last six months, that our highway officials and those officials in charge of the maintenance of such suburban roads have become much alarmed owing to the great damage that has been and is being done by the increase in traffic and the increase in the loads that are being hauled over the roads.

No one can readily be blamed for this condition, as it was impossible to foresee, only a few years ago, when the roads were built, what a sudden increase there would be. It is generally admitted now, however, that in the vicinity of our larger cities, and on routes between large cities, where the advantages for installing intercity motor-truck freight lines are considered favorable for the operation of such lines, only the highest types of roads must be constructed.

Present Regular Lines of Freight-Carrying Motor Trucks

Many regular lines of freight-carrying motor trucks are now operating from Boston, Hartford, New York, Albany, Trenton, Philadelphia, Atlantic City, Baltimore, Wilmington, Del., Washington, Cleveland, Detroit, Chicago, Pittsburgh, Los Angeles, San Francisco, Portland, Seattle and other cities. The longest line operating on a regular schedule at the present time is one between Akron, Ohio, and Boston, Mass., trucks starting from both terminals daily. This line operates seven days a week and each truck makes the round trip of about 1,500 miles in less than a week.

Successful lines are also operating between Chicago and Gary, Ind., twenty-five miles; Chicago to Elkhart, Ind., 110 miles; Chicago to Rockford, Ill., 95 miles, and between Boston, New York, Philadelphia and scores of manufacturing cities within a radius of 50 miles and more.

On the western coast, in the State of California, where, owing to improved roads, we find 42 responsible companies operating fleets of trucks between 60 separate and distinct terminals, and this does not include the intermediate points to which service is rendered through the highway transportation.

Pavements of Most Durable Types are Requisite.

The motor truck freight lines, as well as scores of others in different parts of the country, have thoroughly demonstrated the importance of highway transportation, and that when operated upon properly constructed roads the service is both economical and dependable.

The actual running of these lines has proven beyond all doubt, however, that more attention must be paid to the improvement of roads over which such lines may be expected to run in the future, and that only pavements of the highest and most durable known type should be laid by the officials in charge of the construction of our highways.

The traffic for highway transfer is here and you cannot curtail it. Regardless as to whether we are at war or peace it will continue to grow, and it must be met in an intelligent and sane manner. The building of temporary or cheaply constructed roads insures, in a comparatively short time, that the maintenance and repair charges plus the original cost of construction will more than equal the cost of the higher and more dependable type of pavement.

Baltimore's Street Paving Program for 1918

The Paving Commission of the City of Baltimore has just issued the following lists of streets and alleys selected for improvement in 1918. These lists are tentative. Changes may be made either in the limits of the streets or alleys or the order in which they may be improved. Of course the Commission may add such streets and alleys not mentioned in these lists as may be decided on during the year 1918.

Streets Definitely Selected for Improvement.

Exter St., from Pratt St. to Fleet St. Gough St., from Central Ave. to Lloyd St. Lloyd St., from Gough St. to Granby St. Stiles St., from Central Ave. to East Falls Ave. Charles St., from Read St. to Chase St. Lexington St., from Guilford Ave. to Calvert St. Centre St., from Fallsway to Courtland St. Orleans St., from E. b/l Forest St. to W. b/l Broadway. Caroline St., from N. b/l Pratt St. to S. b/l Monument St. Lanvale St., from E. b/l Fulton Ave. to W. b/l Carrollton Ave. Lanvale St., from E. b/l Arlington Ave. to W. b/l Druid Hill Ave. Franklin from Park Ave. to E. b/l Howard St. Raborg St., from Stockton St. to Greene St. McElderry St., from E. b/l Patterson Park Ave. to E. b/l Luzerne Ave. McElderry St., from E. b/l Wolfe St. to W. b/l Chester St. Jackson St., from E. b/l Aisquith St. to W. b/l Central Ave. St. Matthews St., from E. b/l Central Ave. to S. b/l Lexington St. Sanders St., from W. b/l Covington St. to E. b/l Riverside Ave. Covington St., from N. b/l Gittings St. to S. of Sanders St. Russell St., from Stockholm St. to Fremont Ave.

Alleys Definitely Selected for Improvement.

Jordan Alley, from S. b/l North Ave. to N. of Wilson St. Jordan Alley, from S. b/l Wilson St. to N. b/l Mosher St. Jordan Alley, from S. b/l Lafayette Ave. to N. b/l Biddle St. Tiffany Alley, from N. b/l Orchard St. to S. b/l Lanvale St. Tiffany Alley, from N. b/l Lafayette Ave. to S. b/l Bloom St. Shields Alley, from N. b/l Greenwillow St. to S. b/l Pitcher St. Mason Alley, from S. b/l Dolphin St. to N. b/l Hoffman St. Mason Alley, from S. b/l Preston St. to N. b/l Camel Alley. Camel Alley, from E. b/l Madison Ave. to W. b/l Cathedral St. Jenkins Alley, from N. b/l Hoffman St. to S. b/l Dolphin St. Lovegrove Alley, from S. b/l Franklin St. to N. b/l Elizabeth Ct. Lovegrove Alley, from N. b/l Mt. Royal Ave. to Jones Falls. Lovegrove Alley, from N. b/l Lanvale St. to N. b/l Trenton St. Rice St., from E. b/l Carrollton Ave. to W. b/l Fremont St. Rice St., from W. b/l Carey St. to E. b/l Woodyear St. Woodyear St., from S. b/l Lanvale St. to N. b/l Franklin St. Vincent Alley, from N. b/l Hollins St. to S. b/l Saratoga St. Vincent Alley, from S. b/l Pratt St. to B. & O. Right of Way. Booth St., from W. b/l Carey St. to E. b/l Vincent Alley. Brexton Alley, from S. b/l Eager St. to W. b/l Cathedral St.

Tentative List of Alleys for Improvement in 1918.

Cider Alley, from Paca St. to Greene St. Durst St., from Fort Ave. to Cross St. Mt. Clare Alley, from Lanvale St. to Lafayette Ave. Stump Alley, from Conway St. to Barre St. Bruce St., from Edmondson Ave. to Harlem Ave. Iron Alley, from Baltimore St. to Lombard St. Pin Alley, from Arch St. to Pine St. Boyd Alley (St.), from Parkin St. to Fremont Ave. Stoddard Alley, from Mosher St. to McMechen St. Alley rear 1369 Carey St., from Presstman St. to Laurens St. Pierce St., from Pearl St. to Pine St. Alley N. of and parallel with Jefferson St., from Eden St. to Central Ave.

Tentative List of Streets for Improvement in 1918.

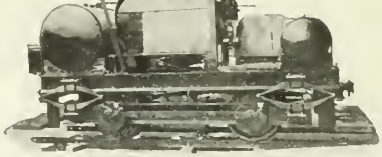
Bank St., from Ellwood Ave. to East Ave. Spring St., from

Biddle St. to Hoffman St. Brentwood Ave., from Biddle St. to Eager St. Barclay St., from Chase St. to Biddle St. Forrest St., from Monument St. to Eager St. Forrest St., from Chase St. to Biddle St. Collington Ave., from Hoffman St. to Federal St. Bethel St., from Pratt St. to Madison St. Mott St., from Gay St. to Ensor St. Stirling St., from Mott St. to Aisquith St. Mullikin St., from Ann St. to Aisquith St. Linwood Ave., from Madison St. to Federal St. Lancaster St., from President St. to Caroline St. Aliceanna St., from East Falls Ave. to Caroline St. Fleet St., from East Falls Ave. to Central Ave. Brevard St., from Wilson St. to North Ave. Somerset St., from Madison St. to Biddle St. York St., from Light St. to Battery St. Henry St., from Key Highway to Water Front. Fayette St., from Poppleton St. to Smallwood St. Lombard St., from Fremont Ave. to Payson St. Federal St., from Broadway to Eastern City Line. Montford Ave., from Pennsylvania Railroad to Lafayette Ave. Montford Ave., from Eager Place to McElderry St. Luzerne St., from Baltimore St. to Madison St. Preston St., from Gay St. to Eastern City Line. Lanvale St., from Fulton Ave. to Payson St. German St., from Eutaw St. to Howard St. Lombard St., from Hanover St. to South St. Payson St., from Lanvale St. to Mosher St. Collington Ave., from Biddle St. to Ashland Ave. Collington Ave., from Pratt St. to Fleet St. Chester St., from Pratt St. to Fleet St. Pratt St., from Broadway to Patterson Park Ave. Graves St., from Monument St. to Madison St. Luzerne St., from Eager St. to Federal St. Biddle St., from Montford Ave to Loney's Lane. Chase St., from Milton Ave to Luzerne St. Milton Ave., from McElderry St. to North Ave. Ellwood Ave., from O'Donnel St to Eastern Ave. Bolton St., from Preston St. to Biddle St Lakewood Ave., from Fait Ave. to Boston St. McDonogh St. from Madison St. to Ashland Ave. Poultney St., from Pa tapsco St. to Light St. Ostend St., from Light St. to William St. Grindell St., from William St. to Riverside Ave. Clemen St., from Jackson St. to Key Highway. Arlington Ave., fron Baltimore St. to Pratt St. Jefferson St., from Milton Ave. t Lakewood Ave. Orleans St., from Milton Ave. to Lakewoo Ave. Ashland Ave., from Patterson Park Ave. to Milton Ave Bond St., from Baltimore St. to Madison St. Hill St., fron Charles St. to Light St. Warner St., from Carey St. to Bayard St. Russell St., from Stockholm St. to Bush St. Winder St. from Light St. to Hanover St. Albemarle St., from Eastern Ave. to Fleet St. Albemarle St., from Baltimore St. to Prat St. William St., from Clement St. to Fort Ave. Clement St from Light St. to William St. Lakewood Ave., from Fayett St. to Baltimore St. Olive St., from Hopewell St. to Clemen St. Lemmon St., from Eutaw St. to Paca St. Clinton St from George St. to Myrtle Ave. Edmondson Ave., from Clin ton St. to Fremont Ave. Federal St., from Broadway to Gay St. Smallwood St., from Lexington St. to Franklin St. Ash land Ave., from Aisquith St. to McKim St. Greenmont Ave. from North Ave. to Hiller St. North Ave., from Port St. t E. b/l Minebank Lane. Lexington St., from Center Ave. t Caroline St. Washington St., from Fayette St. to North Ave Columbia Ave., from Greene St. to Fremont Ave.

Plant Units and Lay Outs

An Oil-burning Steam Locomotive

The oil-burning steam locomotive here illustrated is thoroughly tested under operating conditions and has proved its worth. The Bell unit engine has only 15 moving parts and is geared direct to the axle. It runs in oil and is of first-class construction throughout. The manufacturers claim that it is the most highly developed steam engine made. The engine unit can be removed and replaced in two hours time and requires practically no attention. The horizontal tubular boiler is wire bound and has steel tubes welded into the fire box head and is free of seams and rivets. It is quick firing and



VIEW OF OIL BURNING STEAM LOCOMOTIVE.

gives high-pressure superheated steam. It is easily cleaned. Water is carried in a riveted steel tank, placed just ahead of the boiler, while the liquid fuel is carried in a cylindrical tank located in the engine cab. Water is fed to the boiler from the tank by an injector. Side rods take the drive from the front to the rear wheels.

Locomotives weighing from 2 to 10-tons are equipped with hand operated brakes, while locomotives weighing more than 10 tons are equipped with steam or air brakes, as the buye specifies. The manufacturers can furnish burners for gasoline kerosene, fuel oil, or any kind of liquid fuel. Its design lend itself readily to the production of locomotives that are narrow low and short. With the use of liquid fuel there are no sparks hot ashes or smoke. A licensed engineer is not usually re quired to operate one of these locomotives, even in such locali ties as New York City. Any handy-man of average ability ca operate and care for a Bell locomotive after a few days' prac tice. These locomotives are suitable for contractor's use espe cially.

The center of gravity is as low as possible, and this, in con nection with the flexible frame, permits of high speed on roug tracks. Starting when cold, the locomotive can be fired u and ready for operation in from 15 to 20 minutes. Sizes rang from 2 to 18 tons. These locomotives are manufactured by th Bell Locomotive Works, 30 Church Street, New York City.

An Adjustable Manhole Top

Constantly increasing volume of traffic and extremely heav trucks with heavy loads has presented a problem of stree paving construction which is becoming more and more diff cult to solve. In many cities they are endeavoring to eliminat entirely or at least minimize the placing of manhole covers i the street because of the constant subjection to claim for dam age on account of the broken covers and consequent law suits. Thus we have two city departments working antagonist ically to each other: the Claim Department fighting for th elimination of covers and the Water Works and Sewer Depart ment endeavoring to keep open reasonable means of acces to their underground lines. Many patterns of specially con

structed manhole tops have been patented and put on the market with view to overcoming difficulties. Among these is the S. E. T. Adjustable Manhole Top. It is very practical and efficient and accomplishes the purpose desired.

This top consists of a frame in two parts, the upper part riding on the lower part with corrugated cover resting in the upper part. The lower half has a flange which rests on concrete or brick manhole. Inside it is fitted with a triple set of inclined planes, the upper half having corresponding planes so that when the upper half is put in position, we have one set of planes riding on the other, the whole constituting an adjustable feature with sufficient range to meet ordinary re-adjustment requirements of wearing away of the pavement or slight grade changes.

This manhole top prevents the rattling or dishing out of the cover, first: by the deep flange on the underside of the cover which extends down below the frame lid, and second, by the 4 in. width of the rim of the frame in which the cover rests.

S. E. T. ADJUSTABLE MANHOLE TOP.

The effect of this wide rim is to prevent the cover from disturbance by sudden shocks from heavy and swift traffic because the rim takes the impact. In other words, in the ordinary manhole cover frame the width of rim is only 1 to 1½ in. This rim, especially when projecting at all above the surface of the street, makes an obstruction to the wheel, sending it up into the air and letting it come down square on to the corrugated cover. With the wide rim of the Adjustable Top, the wheel has 4 ins. of surface to run over before reaching the cover. The consequence is, the cover wears uniformly with the rim and always stays in place. The adjustable feature keeps the roadway smooth because of the comparative ease with which it is kept level with the roadway.

A 2-Ton Motor Truck Popular with Contractors

The 2-ton Master truck is proving popular with contractors. Whitlatch Bros., of Beacon, Iowa (general contractors of concrete and structural steel bridge work), report much satisfaction with their Master truck and state they have made many trips heavily loaded, covering a distance of 68 miles through spongy country roads. Conrad Schuck, dealer in coal, stone and builders' supplies, 309 Quay St., Pittsburg, Pa., operated one of these trucks for a period of three months under severe conditions, in nearly every instance hauling over-loads, the loads ranging from 2½ to 3¼ tons. These loads were transported over the hilliest district in Pittsburg, over streets rough for the greater part and unimproved. The Schackleford Brick Co., of Des Moines, Ia., find that their Master does the work that would be a credit to a larger truck and does it on the cost basis of a 2-ton truck. They have operated their truck every day for nearly a year without a cent for repairs.

A Handy Tractor Truck

A tractor truck of much utility is here illustrated. It is of Merchant & Evans Co. manufacture. The truck has a 9-ft. wheel base and a 6x12 ft. body. A longer body can be used. The truck turns completely around in a circle of 9 foot radius. Either steel or rubber tire rear wheels can be used. The truck

THE M. & E. HANDY TRACTOR TRUCK.

has 5-ton capacity and has had almost a year's successful operation. It is estimated that the cost of operating the truck is $8.33 per day, for 300 working days in the year, with an average daily travel of 25 miles. This cost is distributed as follows:

Front tires	$110
Oil and grease	50
Gasoline	310
Garage	180
Driver	720
Insurance	50
	$1420
In addition to this 6% interest on the investment amounts to	$180
20% depreciation	600
Maintenance	300
Making a total overhead charge (annual) of	$1080

Which added to the other expense makes a total,

per year of $2500.00

These trucks are especially appropriate for the use of contractors because of their extreme flexibility of operation.

The New Pneumatic Process of Mixing and Placing Concrete

The New Pneumatic process of mixing and placing concrete is both effective and economical. The concrete is mixed in batches and transported to its final place by means of compressed air acting through pipe lines. The mixing equipment, here illustrated, consists of three hoppers. The first two hoppers are for measuring and mixing the concrete; the third hopper forms part of an air sealed chamber. The material is fed to the upper hopper in its proper proportions of sand, stone, cement and water. This batch then passes through to the second hopper and the first hopper is again ready for an-

other batch. This action imparts the proper motion of rotation to the concrete materials and produces a mix exactly similar to that secured in the familiar batch mixer, except that the contents are rotated instead of the mixer itself. This method of mixing concrete has been in successful operation for years.

After leaving the second hopper the batch enters the third hopper and an air operated door closes this chamber and air is immediately applied to the concrete which in a thoroughly mixed state is conveyed through the discharge pipe to its place in the forms.

The conveying line used is an ordinary 6 in. wrought iron or steel pipe. Any degree of curvature can be introduced into the discharge line without danger of stoppage. The discharge line terminates in a specially constructed nozzle which permits the concrete to be deposited wherever required.

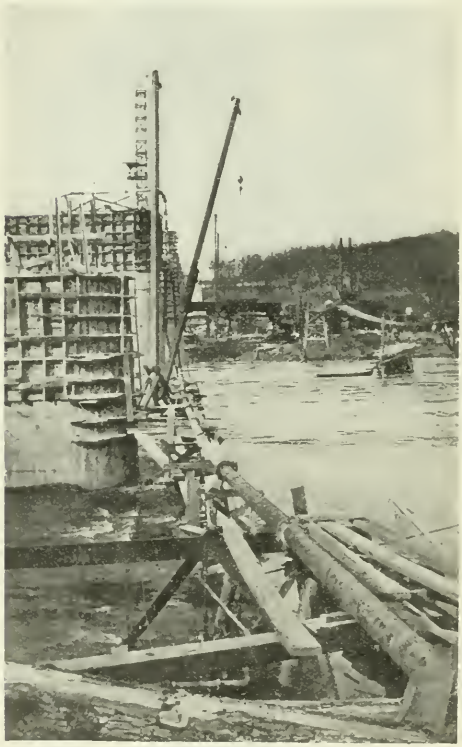
The compressor capacity depends entirely on the quantity of concrete required per unit of time and the distance it is to be conveyed. The maximum distance of conveyance by this method thus far attained is 4,000 ft., but except under extraordinarily favorable conditions, it would be uneconomical to convey concrete to such a great distance. Oftentimes it is possible to install two unit compressors, operating one at short distances and the two on the longer distances.

Especially great are the advantages of this method of mixing and placing concrete on work where concrete is to be deposited at considerable distances from the mixer, whether this distance be horizontal or vertical. Where the forms are difficult of access, this method is also especially appropriate as by it the concrete can be deposited wherever it is possible to lay a pipe line. This method is in operation in this country on all kinds of concrete work, both on heavy mass construction and on thin impervious construction. It is acknowledged to be the most economical method of concreting tunnel lining, sewers, etc.

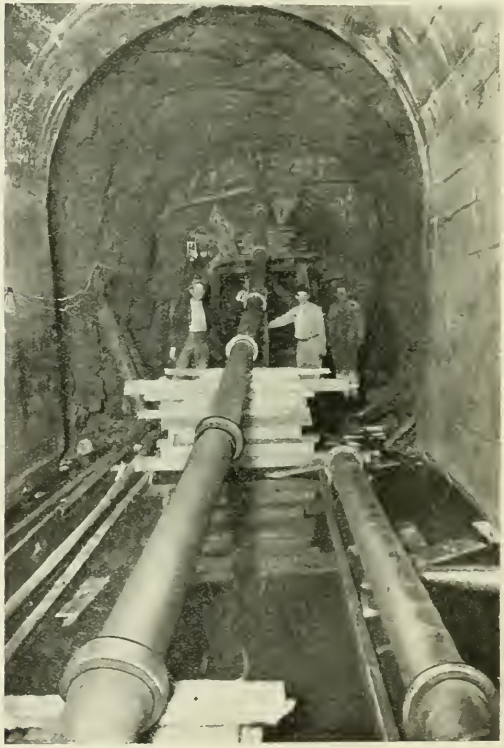
The accompanying views illustrate two successful applications of this method. One view shows a Pneumatic installation for tunnel lining. In tunnel lining by this method, the pipe is usually led along the side of the tunnel out of the way of the miners and other workmen, thus allowing the concreting to continue without interrupting the driving of the tunnel and removing the spoil. The pipe enters the form as illustrated and the concrete is conveyed through it to its final place. Few men are required at the form. The old method in work of this sort is to run the concrete car up an incline, dump on a platform and then a gang of 15 or more men are required to shovel the concrete into place. This is a slow process, especially as the work approaches the key of the arch.

With the Pneumatic method only two or three men are required to watch the forms, bulkhead and pipe. The key of the arch is concreted as quickly as the side wall at the rate of 18 to 25 cu. yds. per hour.

The remaining illustration shows a Penumatic installation used in concreting a bridge pier. On this work the machine was set at about 100 ft. from the pier and the conveying pipe line laid to the base of the pier, with an elbow in the line looking up. As the pier advanced in heighth the pipe line was extended to enable concrete to be placed in the next section of forms. This process was continued until the top of the pier

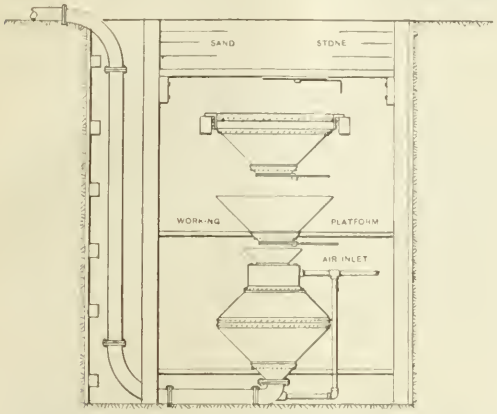


PNEUMATIC INSTALLATION FOR BRIDGE PIER.



PNEUMATIC INSTALLATION FOR TUNNEL LINING.

was reached, a total heighth of 125 ft. On this particular job the Pneumatic method saved the contractor the large and expensive concreting tower. It did not require surplus lumber or a large number of carpenters and reduced the concreting



RELATION OF PARTS IN MIXING EQUIPMENT USED IN NEW PNEUMATIC PROCESS OF MIXING AND PLACING CONCRETE.

gang from the 20 or 25 men that would have been required by the old method to 5 or 6 men by the Pneumatic method. In addition the Pneumatic method speeded up the job and enabled the contractor to complete the work before contract time.

The machinery illustrated and described is manufactured by the Pneumatic Concrete Machinery Co., 2 Rector Street, New York City.

A Portable Scoop Conveyor

A new type of portable belt scoop conveyor is here illustrated. The machine is operated either by electric motor or gasoline engine power and is called the scoop conveyor because the conveying belt receives its material through a scoop which can be pushed or completely buried in the material to be conveyed. The object of the scoop conveyor is to provide a portable machine that can be readily handled by one man for the purpose of loading and unloading and stacking and re-

PORTABLE BELT SCOOP CONVEYOR.

claiming loose materials such as crushed stone, sand, gravel, coal, coke, ashes, etc. The conveyor has a wide range of application. The manufacturers of this conveyor claim that it will also handle sacks and packages, boxes and various manufactured products and that one operator and the conveyor will handle loose materials at the rate of one ton in 1½ minutes. Keeping cars and trucks moving and cutting the cost of men shoveling are highly desirable in present war-time conditions and this machine will do much to accomplish these ends.

Portable Asphalt Plants Retain Popularity

While in the city of Chicago stationary asphalt plants are much used, the portable type is a favorite in the near-by cities and towns. During the construction season of 1917 these portable plants were much used in the Chicago territory. The R. F. Conway Company operated two Cummer plants last year, one of the railroad and the other of the portable type. They laid 90,000 sq. yds. with the former and 75,000 sq. yds. with the latter. The work was done in Cicero, Joliet and Berwyn, Ill. Transportation of the materials to the plant was by rail in all cases, and the prepared paving material was hauled from the plant exclusively by motor truck for an average distance of 3 miles. Ten trucks were used, mostly Macks of 7½ tons capacity. The average daily run of the portable plant was 1,800 yds. binder and surface complete. On asphaltic concrete the average daily run of the portable plant was 2,200 yds. The corresponding maximum figures were 2,100 and 2,700 yds., respectively. In operating the portable plant the gang organization was as follows: 4 to 5 men shoveling to machine, 4 rakers, 2 rollermen, 2 tampers, 1 smoother, 1 foreman, 2 engineers and 2 or 3 extra laborers. The plant was operated from team tracks. Both Mexican and Trinidad asphalts were used. Coal was used for the melting and other purposes on the Joliet work because of limited oil storage facilities. At Cicero coal was used for the melting and oil for the boilers and drums. The use of oil for the drums is 20 per cent. more efficient than coal, as it makes a quick heat, thereby shortening the warming-up and cooling-off periods. On this class of work the Conway Company have found motor haulage 25 per cent. less expensive than horse haulage.

The White Construction Company, of Milwaukee, have also used portable plants extensively for the past five years. Last year they used two Cummer portable plants on work in South Bend, Ind., and Portage and Milwaukee, Wis. They placed 270,000 yds. with the two plants. Mr. White says that an average annual output for one of these portable plants is 175,000 sq. yds., and one year in Milwaukee he laid 200,000 sq. yds. from one plant. He has operated three Cummer plants during the last five years.

H. G. Goelitz, contractor on municipal work, Oak Park, Ill., laid 70,000 yds. last year with a Cummer portable plant. This work was done in Oak Park, Berwyn, Cicero and Evanston, Ill. Trinidad asphalt was used. In all cases he handled these jobs from grading to final paving, using a Keystone shovel extensively on the grading. A 6-in. concrete base was laid in all cases, and on this was laid 2 ins. of asphaltic concrete, with the exception of one Evanston street, where 3 ins. of sheet asphalt was laid. He has operated a Cummer plant three years and a Merriman car plant one year. Like the other contractors, he is especially enthusiastic about the dryer on the Cummer plant. He operated this year exclusively from team tracks, unloading direct to the plant. Both horse and motor haulage were employed in hauling the prepared materials. The wagons were of the dump variety and rendered good service. Three Garford 7-ton trucks were used, the average haul being 2 miles. His daily average yardage was 1,000 and his maximum 1,800. There were many delays due to the abnormal labor conditions.

In the big cities where streets are paved in "systems"—that is, when many blocks on adjacent streets are paved simultaneously—the stationary asphalt plant is popular. In the smaller cities and on highways—that is, where the pavement runs to great length in proportion to the total yardage placed—the portable plant possesses advantages and fills a distinct field of usefulness.

LIGHTS AND SHADES

The High Cost of Pick Handles

Two sons of Erin were digging a ditch for a gas-main. One of them was slightly handicapped by the shortness of the handle on his pick. His back was aching from bending over so far and he had paused for a moment, when his companion remarked:

"Say, Mike, phwat wud ye do ef ye had a million dollars?"

"I'd add four inches to the handle o' this pick," was the reply.

Gambling on the Green is Out of Date

Time was when the youths and maidens gamboled on the green. Greens were plentiful in those days. Now we have paved areas instead and many children have no playground but the paved street. Recently we saw a picture of an exciting tennis match played on a smooth brick pavement. Now comes word of a dance on a bitulithic pavement in Grinnell, Iowa. This dance was conducted by the "Best People on Earth" and their ladies. A half block of the pavement was roped off and those who know say it was an excellent dancing floor. A flashlight picture of the dancers was taken and sent to Contractor Harrabin who built this pavement eight years ago.

Unique Identification

In a certain central city, celebrated for the excellence of its water purification and sewage treatment plants, two brothers have made fine records by their skillful and progressive methods of operating these plants. Brother C. P. has charge of the water purification plant and brother C. B. of the sewage treatment plant. Naturally sanitarians often confused the two names, so a unique means of identification was suggested, by an eminent sanitarian, running thus: C. P., chemically pure, in charge of water purification plant; C. B., chemically bad, in charge of sewage treatment plant.

The Value of Pure Water

Engineers oftentimes have occasion to address the public on the value of a pure public water supply. Here is an illustration that may be helpful. It is the custom, we believe, to use distilled water in electric storage batteries, but in a certain city, which has a modern water purifying and softening plant, the electrical supply houses simply turn on the tap and sell the city water for 25 cts. per gallon as distilled water and get away with it. The tap water is as good as distilled or it wouldn't work.

The Origin of a Utility Baron

J. B. Quigley, working as a surveyor in his younger days, happened to fall into a water-hole. Down at the bottom the water was frigid; but on the surface it was warm. An idea came to Quigley for a new kind of water-cooler—one that would not allow the ice to float on the surface in contact with the warm water. He invented it. The Missouri Pacific tried it out, found it saved ice, and bought it for $12,000. Quigley used the $12,000 to start out as a promoter, and at one time was president of twenty-five different public-utility corporations—all from falling into a soft place and getting the habit.

Damper Than a Deckhand on a Submarine

An affluent American contractor in London went to have a look at the Thames. There was a steam shovel dredging in the river and he stood watching it——wondering how his shovels back home were working. Suddenly he felt a tap on his shoulder and turned to face a young lad, fresh from the Emerald Isle. "Say," said the youth, "isn't London a wonderful place? By gorry, now just look at that thing goin' down there; now, look at it; isn't that wonderful? But, say I wouldn't want to be the man at the bottom filling that thing up."

Don't be Deceived by a Monocle

To show what a good sport that young English officer is, here is a typical one coming down the road; he is a captain of engineers. He is swinging his little cane, his eyeglass in his eye, and he meets a Canadian sergeant and four or five men, and it may be these Canadian boys had been drinking something stronger than water, otherwise the sergeant would not have been guilty of the grave discourtesy he showed his superior officer.

Said the officer: "Sergeant, by the way, can you tell me the road to—my word, I have forgotten the place, but can you tell me the road?" The sergeant pulled out a big Belgian penny, just about the size of an American fifty-cent piece, only made of copper; he carefully screwed this Belgian penny in his eye and he said, "No, sir, I cannot tell you the road there."

Now, that young officer might have arrested that sergeant, had his stripes torn from him and reduced him to the ranks, and earned the ill will of his companions and perhaps of many Canadians. But he looked at that sergeant for a moment with his eyeglass, dropped his eyeglass out of his eye into the palm of his hand, flipped it up into the air, and unaided caught it in his eye, looked at the sergeant and said, "Aw, aw, do that, you blighter, do that, you blighter." Oh, you have got to know the Englishman in war before you really appreciate him.

The Alderman Retorts

A contractor was excitedly urging upon a Chicago alderman the perfectly good reasons why the city should continue making public improvements during the war. The alderman listened closely—just as if he were being told something for the first time. "Say," said the contractor, "didn't you read all those letters, signed by taxpayers, published in The Friend of the People, in the Tribune this morning?" "Did you write those letters yourself, Charlie?" asked the alderman, and the laugh that went up from the contractors and material men present was a roaring shout.

Mr. Perch Meet Mr. Carp

Some misguided engineer has exhumed the perch from its tomb. Like the carp, the perch is in wrong. This engineer, a road engineer, in calling for bids, scheduled his quantities by the perch. What is a perch. Who knows? It has a different meaning in every locality, and that is why it was abandoned more than thirty years ago in favor of the cubic yard, which is a model of constancy.

FIRE ENGINEERING

Procedure in Maintenance of Fire Hydrants in Minneapolis

In Minneapolis fire hydrants are set with the center of the branch 8 ft. below the street grade. There are 5,627 in service and to maintain them in proper working condition 70,202 inspections were made last year, which gives an average of 12 visits or inspections per hydrant per year.

The maintenance of hydrants consists of testing, replacing valve leathers and other parts, oiling and painting. Constant inspection is necessary during the winter to see that the hydrants do not become frozen. In the congested value districts hydrants are inspected daily in the winter. In residential districts hydrants are inspected once each week. Sometimes it is necessary to uncover hydrants so they can be found after heavy snowfalls.

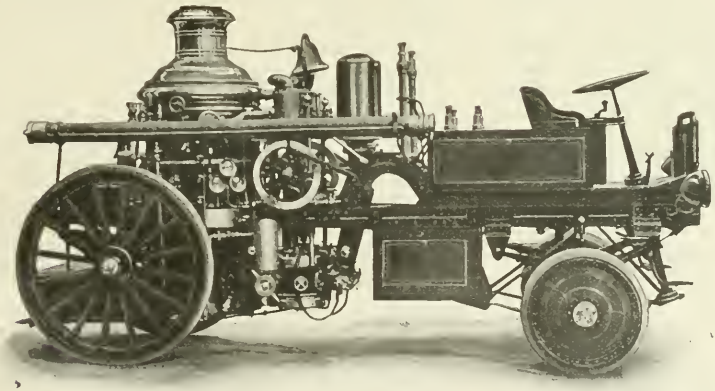
The inspector tests the hydrant for frost in various ways. Sounding by the hand and test by plummet usually reveal any trouble that may require further attention, such as operating the hydrant or using thawing appliances. The cost of inspection work was 6.9 ct. per hydrant for the year. Large buildings which extend their area walls to the curb encroach on hydrant space. The regulations require the hydrants to be walled off from the basements in such cases to keep out the drip water. Where the basements are not heated the cold walls in this climate afford favorable conditions for frost penetration by following down the masonry to the base of the hydrants. In the congested districts hydrant branches occasionally freeze if the branch is close to a catchbasin or manhole. The practice of locating hydrants on the property line at street intersections was abandoned several years ago. Now they are set back 10 ft. from the property line, thus keeping clear of the space usually occupied by catchbasins. All hydrants in use are of the Mathews type. Originally, even in this climate, it was thought necessary either to set the hydrants in brick chambers protected by shavings or to use the common form of iron frost jackets. For the past 7 years a type of hydrant has been in use which has no frost jacket or chamber. The hydrant is buried in the usual way and gives no more trouble than hydrants set according to former methods. The working parts can be removed by removing the bonnet and raising them by means of tripod, which, of course, must be quite high for a hydrant buried 8 ft.

An Electric Steamer's Record

Steamer No. 217 of the New York City fire department, stationed at De Kalb and Lewis avenues, Brooklyn, is said to have been the first electrically-driven piece of fire apparatus put into service in this country. That was only a few years ago, and it was generally predicted that six months' time would see the "new-fangled thing" on the scrap heap. Despite these forebodings, however, the engine is still at work, and its record may well be studied by anyone who still is skeptical of electric fire apparatus efficiency and practicability.

No. 217 was originally a horse-drawn steamer of the largest size, but was converted to the motor type by the removal of its forward running gear and the substitution of a couple gear tractor and a storage battery.

This transformation cost $4,000, and it gave New York City an engine which would have cost not less than $10,000 had new apparatus been purchased. In other words, a dependable steam pumper was continued in service with added speed and a greatly enlarged radius of operation.



COUPLE-GEAR CHASSIS AS USED IN MOTORIZATION OF HORSE-DRAWN STEAMER BY THE CITY OF GRAND RAPIDS, MICHIGAN.

With the exception of battery renewals and replacement of minor parts, No. 217 stands today just as it did when first it went into service on April 24, 1912. The bills for repairs and renewals during the two years have come to just $744.29, $486.97 of which was for battery renewals that were made after the machine had been in service a year and a half. The balance includes minor parts, labor and decorating for the engine to take part in two street parades. Adding depreciation and the cost of charging, operation of this engine has cost the city just $1,370.03.

The cost of motive power for this same type of engine, but with horse instead of battery, is $1,469.06 for two years. These figures are based on the records of two companies, which ordinarily respond to about the same number of calls as No. 217. The sum includes depreciation on horses and harness and stable equipment, which at 10 per cent. is $105.98 a year.

Feed, shoes and veterinary service for three horses cost $516.86, while the repairs vary. As a rule, better service costs more money. In this case the fire department not only has a better piece of apparatus, but one on which it is saving money. The economy claim is supported by the records of the department—the claim of superiority is based on the actual performance of the engine.

In the case of fire fighting this is rated principally by the speed in getting to the blaze. To begin with, the engine saves time in getting out of the house, for there are no horses to harness. Incidentally the passing of the horse has done away with the stalls, and the space thus saved is utilized for garaging the car of one of the department chaplains. With no time lost in harnessing and with the greater speed thru the streets and a wider range of operation, No. 217 is often the first engine at hydrants, to which in the days of the horses it was due third. Considering these things, is it odd that the skeptic has since become a convert?

Personal Items

E. L. Gastin was recently appointed City Engineer of Macon, Ga.

Lewis B. Sebring has recently been appointed City Engineer of Schenectady, N. Y.

Warren R. Neel was recently appointed Chief Engineer of the State Highway Department in Georgia.

Geo. S. Pierson, of Kalamazoo, Mich., has been appointed County Highway Engineer of Kalamazoo County.

L. M. Russell, of Elkhart, Indiana, and Arthur J. Sweet, Consulting Engineer of Milwaukee, Wis., are now associated in business at the latter place. Mr. Russel was formerly City Engineer of Elkhart, Indiana.

J. F. Bowan has been reappointed City Engineer of Manchester, Conn.

J. J. Lavery was recently appointed City Engineer of Summit, New Jersey. He was formerly City Engineer of White Plains, New York.

Alfred D. Butler, formerly Assistant City Engineer of Spokane, Wash., has been appointed City Engineer to succeed Morton Macartney, who resigned the position of City Engineer to enter private consulting practice.

Prof. R. C. Yeomans, for many years Dean of the Engineering Department at Valparaiso University, Valparaiso, Ind., has been appointed Assistant Professor of Highway Engineering of Purdue University to succeed Prof. D. E. Martin, now with the U. S. Engineer corps.

Thos. W. Cothran has been appointed by the Governor of South Carolina as Chairman of the State Highway Commission to succeed Major J. Monroe Johnson, now at the head of the South Carolina Battalion of Army Engineers. Mr. Cothran is a trained civil engineer.

C. M. Osborn has been appointed City Manager of East Cleveland, Ohio, a suburb of Cleveland. For the past 10 years Mr. Osborn was City Engineer of Lorrain.

Chalmers Miller, for two years Asst. City Engineer in Lorrain, Ohio, has been appointed City Engineer to succeed C. M. Osborn, who resigned.

J. H. Hallett has been appointed Asst. City Engineer of Jackson, North Carolina. He was formerly Chief Clerk of the City Engineering Department.

M. Hannah has been appointed County Engineer of McLennan County, Texas, to succeed R. J. Windrow, who recently resigned this position to become State Water Engineer. Mr. Hannah was formerly County Engineer of Lamar County and later Assistant County Engineer of McLennan County.

Prof. J. Madison Porter, for 28 years Professor of Civil Engineering at Lafayette College, has resigned to devote all of his time to other business. He is succeeded in this position by A. H. Fuller.

R. W. Gerhart has been appointed County Engineer of Linn County, Iowa. He resigned the office of County Engineer of Buchanan County to accept his present position.

H. Lester Newhall is now principal assistant to the Chief Engineer of the Akron, Ohio, waterworks system. He was formerly Assistant Engineer of the Public Service Commission of New York.

J. B. Marcellus has been appointed State Drainage and Consulting Engineer of Kansas, with offices at Manhattan. He was recently in charge of the work of the Portland Cement Assn., at Kansas City, Mo. In his present position his work will be in connection with the extension division of the Kansas State College of Agriculture and the Mechanical Arts.

L. H. Powell, City Engineer of Tyler, Texas, has been appointed as consulting engineer for road district No. 1, Sheridan County, Texas, also.

H. C. Allen of Wallace, Idaho, was recently appointed State Highway Engineer to succeed E. M. Booth. Mr. Booth held the position for 2½ years and resigned to enter the Army Engineering Service.

Hall Mollitor, superintendent of operation of the sewage treatment plant at Chatham, New Jersey, has been reappointed to that position for another year.

Geo. C. Habermeyer, of Urbana, Ill., has been appointed acting Director of the Illinois State Water Survey, and acting Secretary of the Illinois Section of the American Water Works Association, to serve in place of Prof. Edw. Bartow, who is now in Military Service.

W. B. Dubny has been appointed Highway Engineer of the Monticello, Miss., District to succeed E. B. Blanchard, who has removed to Yazoo City, Miss., where he will act as Highway Engineer.

M. M. Cook has been elected City Engineer of Wichita Falls, Texas, to succeed L. C. Hinckley, who died recently.

Donald M. Baker was recently appointed Engineer of the California State Water Commission. He was formerly Deputy County Surveyor in Orange County, California.

Burdette Woodyard of Parkersburg, W. V., was recently appointed State Inspector of Roads for the State Highway Department of W. Va. Mr. Woodyard has had much experience in the construction of concrete roads in particular, notably in Wood County.

Hale Judson has been promoted from Assistant Engineer to City Engineer of St. Joseph, Mo., to succeed Carl B. Hoof, who resigned.

M. C. Eaoes, Chairman of the Alaskan Engineering Commission, will spend the winter in Washington, D. C. He will go before Congress to present the claims of the Alaskan Railroad for appropriations for the year 1918.

Chas. C. Huffine was recently appointed City Civil Engineer of Frankfort, Indiana.

H. Gordon Hinkle has been appointed City Manager of Altoona, Pa. He was formerly County Engineer of Blair County, Pa.

C. G. YOUNG has entered the organization of Ford, Bacon & Davis, New York, where he will devote his time principally to making reports and appraisals of public utility and industrial projects and properties. He has been well known for years in the Public Utility field.

F. H. WILLIAMS, formerly City Manager of Brownsville, Texas, has resigned his position because of poor health. A successor will be appointed at once.

CALVIN W. HENDRICK, formerly Chief Engineer of the city of Baltimore, Md., who built Baltimore's comprehensive sewage collection and disposal works, has become the President and General Manager of the W. Virginia Coal & Timber Co., a $600,000 corporation recently organized by business men of Baltimore. The company has acquired and will develop 32,000 acres of coal and timber land in W. Virginia. Before going to Baltimore Mr. Hendricks had charge of the reconstruction of the sewage collection system in New York City.

R. D. LEE has been appointed City Engineer of Hutchinson, Kans., to succeed G. L. McLane, who is now in the U. S. Army Engineer Corps.

MATT GRAHAM has been appointed City Manager and City Engineer of Augusta, Kansas. He was in the employ of Black & Veatch, Consulting Engineers, of Kansas City, for six years and later was with the Western Brick Manufacturers Association.

BERT W. WELLS has been appointed City Manager of Eldorado, Kans. For eight years he was City Engineer of Wichita, where he has been succeeded by P. F. Brockway, formerly Assistant City Engineer.

NEIL COVENTRY was recently appointed City Engineer, Harrison, Idaho.

CAPT. H. S. BAKER, Construction Quartermaster at Camp Bowie, Fort Worth, Texas, who is principal assistant City Engineer of Chicago, on furlough, has been commissioned as a Lieut. Col. of Engineers in the National Army.

CHAIRMAN BENSON, of the Oregon State Highway Commission, has announced that Oregon will continue work on all highway projects this year.

A. J. MELTON, President of the United Contracting Co., has just finished 1½ miles of road near Vancouver, Wash. This is a 4 in. concrete base, with a 2 in. bitulithic top.

CHAS. H. CLIFFORD, formerly Superintendent of Streets in Portland, Maine, is now a Capt. of Engineers in the National Army.

L. C. CLARK, County Engineer of Leavenworth County, Kansas, called a County Road Meeting late in November, which proved to be a well-planned and enthusiastic county meeting. Practically every highway official and good roads enthusiast in the county attended.

W. S. KING, well known through the middle Southern States as a government building contractor and who has had contracts for over 50 such buildings, and D. J. McCanne, a well known Civil and Electrical Engineer of Denver, Colo., have formed the firm of McCanne-King Co., in El Paso, Texas. They have installed heating and plumbing equipment in numerous large buildings.

JOHN H. GREGORY, Consulting Engineer, 170 Broadway, New York, has been employed by the Board of City Commissioners of Fort Worth, Texas, to prepare plans for the enlargement of the City Water Filtration Plant. The addition will consist of rapid filters, new settling basins, mixing chamber, chemical house and aeration.

GUSTAVE R. TUSKA, Consulting Engineer, of New York City, formerly Chief Engineer of the Panama Railroad Co., and lecturer in Engineering at Columbia University, has been commissioned as Major in the Engineer Section of the Officers' Reserve Corps of the United States Army.

COMING CONVENTIONS

NEW JERSEY STATE LEAGUE OF MUNICIPALITIES—Annual convention at Trenton, Jan. 3-4. Sec'y, Clinton A. Swartz, Trenton.

NORTHWESTERN SOCIETY OF HIGHWAY ENGINEERS—Annual convention at Benson Hotel, Portland, Ore. Sec'y, C. G. Reiter, Hillsboro, Oregon.

VIRGINIA GOOD ROADS ASSOCIATION—Annual convention at Richmond, Jan. 15-17, 1918. Sec'y, C. B. Scott, Richmond.

AMERICAN WOOD PRESERVERS' ASSOCIATION—Annual convention at Chicago, Jan. 22-24. Sec'y, F. J. Angier, Baltimore & Ohio Railroad, Mount Royal Station, Baltimore, Md.

AMERICAN CONCRETE INSTITUTE—Annual meeting at Chicago, Feb. 7-9. Sec'y, Harold D. Hynds, 27 School St., Boston, Mass.

CONTRACTORS AND BUILDERS SHOW—Supersedes annual Chicago Cement Show. To be held under auspices of the National Exhibition Co., 123 West Madison St., at the Coliseum, Feb. 6-13, 1918.

AMERICAN CONCRETE PIPE ASSOCIATION—Annual convention at Hotel Sherman, Chicago, Feb. 8-9. Sec'y, J. H. Libberton, 208 S. LaSalle St., Chicago.

IOWA ENGINEERING SOCIETY—Annual meeting at Waterloo, Feb. 20-21. Sec'y, J. H. Dunlap, Iowa City, Ia.

UNITED STATES GOOD ROADS MACHINERY EXHIBIT—Exhibit at Little Rock, Ark., April 15-19. Sec'y J. A. Rountree, 1,021 Brown-Marx Bldg., Birmingham, Ala.

UNITED STATES GOOD ROADS ASSOCIATION—Will convene in Little Rock, Ark., April 15-17. U. S. Senator J. H. Bankhead, Pres. Sec'y, J. A. Rountree, 1,021 Brown-Marx Bldg., Birmingham, Ala.

BANKHEAD NATIONAL HIGHWAY ASSOCIATION—Will convene in Little Rock, Ark., April 18-19. T. S. Plowman, Pres. Sec'y, J. A. Rountree, 1021 Brown-Marx Bldg., Birmingham, Ala.

CATALOG REVIEWS

Turbine Pumps.—Turbine pumps for high head service. Issued by Worthington Pump and Machinery Corporation, 115 Broadway, New York; 6x9 ins.; 32 pp. Illustrates and describes pumps, explains principle of operation and discusses characteristics of turbine pumps. Gives field of application, including fire and water service.

Volute Centrifugal Pumps.—Issued by Worthington Pump and Machinery Corporation. 6x9 ins.; 32 pp. Illustrates and describes pumps of this class, of both single and double suction. Discusses direct-connected, belt-driven, vertical shaft and geared turbine driven pumps. Shows application to water works service, sewage pumping and irrigation and drainage service.

Power Machinery.—Rotary converters, motor generator sets and frequency changes. Issued by MacGovern & Co., 114 Liberty St., New York. 9x14 ins.; 10 pp. Lists machinery in stock for prompt shipment.

Water Meters.—Worthington meters. Issued by Worthington Pump and Machinery Corporation. 6x9 ins.; 12 pp. Illustrates and describes the Worthington flat disc meter. Lists parts and gives instructions for reading meters. Also shows Worthington fish trap.

Concrete Spouting Equipment.—Illustrates, describes and shows application of this equipment. Issued by H. B. Sackett Screen & Chute Co., 1679 Elston Ave., Chicago. 6x9 ins.; 16 pp. Shows plant layouts, hoists, hoppers, buckets, chutes, spouts and concreting carts, buckets, cars, etc. Also portable track and switches.

Concrete Highway Construction.—Issued by the Atlas Portland Cement Company, New York. 8½x11 ins.; 24 pp. Enumerates essentials of a good highway. Gives illustrated general description of concrete road design and construction. Gives equipment and organization required. Gives itemized proposals for concrete road construction and tells how to fill them out intelligently.

Labor-Saving Equipment.—Catalog and price list of the Lee Line of labor-saving equipment used for hauling loose materials, including Lee loaders and dump bodies for motor trucks, trailers and wagons. Issued by Lee Loader & Body Co., 2343 S. La Salle St., Chicago.

Concrete Mixers.—The Archer special mixer illustrated and described. Issued by the Archer Iron Works, 34th Place and Western Ave., Chicago. 6x9 ins.; 16 pp. Shows advantages of portability and end-discharge.

Ultra-Violet Ray Sterilizers.—Issued by the R. U. V. Co., Inc., New York. 8½x11¼ ins. Discusses water sterilization by this method and illustrates and describes the requisite equipment. Bulletins Nos. 1 to 6, inclusive.

Sewage Siphons.—Miller siphons for flushing sewers and for handling sewage in treatment plants and elsewhere. Issued by the Pacific Flush Tank Co., 149 Broadway, New York. Explains principles of operation. Gives suggestions for flush tank specifications. Discusses Jointite for joining sewer pipes. Takes up sewage disposal with reference to domestic installations, sand filters, alternating and time-controlled apparatus, contact beds, sprinkling filters, Taylor nozzles and Imhoff tanks.

Water Chlorination.—Pamphlets issued by Wallace & Tiernan Co., Inc., New York, entitled: Protecting the Water Supply of Greater New York; Automatic Liquid Chlorine Water Disinfecting Plant; Wallace & Tiernan Bacteriological Testing Outfit; Why; and, Chlorination at Dunwoodie. Consists of general and specific information on the sterilization of public water supplies by application of liquid chlorine. Gives technique of application and illustrates requisite apparatus. Gives operating data.

TRADE NOTES

Forrest J. Alvin, general manager of the United States Motor Truck Company of Cincinnati, recently announced plans of the company to greatly increase its production for 1918 with a consequent increase in sales distribution. The company is now closing with wide-awake distributors who have hitherto been unable to secure trucks from the company which was unwilling to make the appointments until prepared to deliver on schedule.

W. Owen Thomas, the consulting engineer of Detroit, says that America will have need for every motor truck ordered for service in America and over seas in connection with the war. Mr. Thomas was chief of mechanical transport for the Canadian army for two years and General Sir Sam Hughes credited the Detroiter with putting Canada at the front a year ahead of its time.

B. F. Affleck, Chicago, was re-elected president of the Portland Cement Association at its annual meeting at the Hotel Biltmore, New York, December 12. Mr. Affleck is president of the Universal Portland Cement Co. The Portland Cement Association has turned its activities largely to the promotion of permanent roads, in line with the desire of the Council of National Defense that through routes be quickly developed to supplement the railways, especially for short-haul traffic. F. W. Kelley, president, Helderberg Cement Co., Albany, N. Y., was elected first vice president, and Richard Hardy, president, Dixie Portland Cement Co., Chattanooga, Second Vice President. G. S. Brown, president, Alpha Portland Cement Co., Easton, Pa., was elected treasurer.

L. F. Hamilton, for several years manager of the advertising department of the National Tube Co., Pittsburgh, has accepted a similar position with the Walworth Mfg. Co., Boston, which, on August 1, purchased the Kewanee works of the National Tube Co. Mr. Hamilton was born in Kewanee, Ill. He was graduated from the University of Illinois in 1897. He was with the Western Tube Co. until 1908, advancing from claim department and secretary to sales manager. From 1908 to 1917 he was with the National Tube Co. He was identified with the advertising success of the "Kewanee" union, the "Shelby" tubing and the "National" pipe. He has been a contributor to advertising periodicals and speaker on advertising subjects. Several technical advertising men are graduates from National Tube Co. Advertising Department, obtaining their training under Mr. Hamilton, including: W. A. Phillis, advertising manager the Borden Co., Warren, O.; Wm. J. S. Ritscher, advertising manager Petroleum Iron Works Co. of Ohio, Sharon, Pa.; G. E. Land, advertising manager Blaw-Knox Co., Pittsburgh, Pa.

Using Dynamite in Ditching Wet Spots

Ordinarily the construction of proper drainage ditches in wet, soggy ground is a very difficult matter. Horses, tractors and machinery can seldom be used on account of getting mired in the mud and hand labor is entirely too scarce and expensive to be used for such purposes.

One very successful road contractor uses large amounts of dynamite in general road work and finds it of great assistance in ditching these wet spots. He uses the electrical method of firing, making the holes about 6 in. shallower than the grade line desired and placing them about 30 in. apart along the center line of the proposed ditch. The charges of dynamite are primed with an electric blasting cap, placed in the holes and well tamped. The electric cap wires are connected up in series and fired by a blasting machine. In this manner the entire line of charges explodes at the same instant, lifting the dirt high in the air and scattering it over the surrounding land, thus doing away with high banks of earth along the ditch.

He has become so successful at this kind of work that by proper loading there is no hand work to be done after the blast, as the ditch is left clean and clear of all debris, ready for immediate use. A ditch averaging 4 ft. deep and 8 ft. wide on top can be made in this manner without the aid of a shovel of any kind. From 1 to 1½ lbs. of 40 per cent low-freezing dynamite per hole is sufficient loading for this size of ditch in heavy soil.

The contractor claims that this method is most satisfactory from his standpoint on account of economy, because of its quickness and because of the saving in hand labor, which at this time of serious labor shortage is an all-important item.

VOL. LIV.
No. 2.

Municipal Engineering

CHICAGO, ILL.
FEBRUARY, 1918.

Design, Construction, Operation and Maintenance of all Public Works

For Military Highways and Main Market Roads

Good highways were never so much appreciated by the analytical as on the recent day when the fuel administrator issued his unprecedented order with a view to conserving the available coal supply. The word available is stressed, for the shortage of coal at the point of consumption is not due to a depletion of coal deposits, or even to inadequate coal mining, but is due primarily to poor transportation and distribution of coal after it is mined. That relief from these intolerable conditions can come only from comprehensive highway construction is easily shown.

About two years ago the Illinois State Geologist stated that less than one-half of 1 per cent of the known deposits of coal in this country had been mined out. There is no trouble on that point. The coal interests, both the owners and the miners' organizations, assert that coal is being mined in amounts which should be sufficient to meet the demand, and lay the blame for the trouble on the overburdened railroads; and the best information obtainable indicates that the inability of the railroads to handle the freight brought to them is the principal factor contributing to the coal shortage.

There was a time when we pitied the poor Indian who froze to death on top of a coal deposit because he didn't have sense enough to dig down for the coal. Thus was the inferiority of the red man established. The white man is smart enough to mine the coal, but he hasn't yet shown his ability to distribute it. He hasn't such a long intellectual lead over the red man as he thought.

The railways have been overtaxed for two reasons: they have been called on to handle an abnormally great and totally unexpected volume of traffic, and their facilities for handling even normal traffic have not kept pace with the peace time requirements of the country. In recent years railroad construction has hovered around the lowest level reached in a quarter century, and rolling stock and other physical property of the roads has been allowed to depreciate.

To attempt to fix the origin of the railway trouble is as idle as to discuss the classic hen and egg controversy. After centuries of debating this question, there is still lack of agreement as to whether the hen or the egg first came into the world. We might discuss the railway question for an equally long period without deciding whether the roads or the public are most to blame, but we haven't time—the Germans won't let us.

With the government operating the railroads there is no great relief in sight from those utilities. So far it is not known whether government control will terminate with the war or not, but it is doubtful if it will. This question is likely to be made a political football, for use after the war, to replace the antiquated tariff issue. Clearly relief must come soon, and we must turn to the highways for it, as the railroads have been found wanting, whether that be their fault, or that of the people, or that of the federal government, or of the forty-eight state governments, or of all combined.

Recently the fuel administrator stated that because of poor railroad facilities the shortage of bituminous coal this year amounts to 35,000,000 tons. Clearly the railroads lack the punch necessary to end this war by a knock-out. They marked time too long in the upbuilding of their properties. Whether they held back because of too much adverse legislation and too much government control, or whether they were prompted by motives akin to those of the beggar who encases his sound arm in a sling, it is now unnecessary and perhaps it would be impertinent to inquire. The summation of all factors in this problem has been made, and the result was the shutting down of the industries of half a continent.

Long before the railroads find out how they stand as to finance, management, ownership, etc., we must construct a system of comprehensive military highways and main market roads. Never again must the greatest coal-producing and the wealthiest nation on earth be made to close down its industries because it cannot distribute the coal already mined. Trunk line highways, if immediately begun, will by next winter make impossible a repetition of this year's unhappy experience. Such roads, with the aid of the motor truck, will relieve the railroads to such a degree that great congestion of rail traffic will not again occur.

Such roads will prevent coal shortages by handling coal direct and by handling other classes of freight on hauls up to 75 or 100 miles, leaving the steam lines free to handle the long-haul shipments. The distances named are, at present, considered about the limit of economical haulage with motor trucks on the highways, but they are likely to be increased materially as a result of experience and with the aid of a comprehensive system of first-class roads. Even uneconomical haulage at greater distances is preferable to no delivery at all. The cost of the shut-down in all states east of the Mississippi river, and in Louisiana and Minnesota, would make a very respectable start on the cost of adequate trunk line highways.

That this is a war problem we are well aware. Let us solve it rightly and at once. This is the people's war—yours, ours, everybody's. We must fight it and we must pay for it, and, above all, we must win it. To win it we must have adequate highway facilities, which, fortunately, will be of permanent value after the war is won.

Let us build these roads, win the war, and definitely and finally prove that we are a more intelligent race than the Indians who perished from cold because they couldn't cope successfully with the fuel problem.

Shall We Encourage a Revival of Sectionalism?

There is now a law on the federal statute books which, if permitted to become effective, will inevitably lead to a revival of sectionalism in this country. This law pertains to the second-class postage rate, and, unless repealed, will become effective on August 1 next. This ill-considered legislation was enacted in the pres-

ent revenue bill and divides the country up into zones. It will progressively increase the average cost of distributing newspapers and periodicals from 50 to 900 per cent. This will destroy many magazines of national circulation which, since the war started in Europe in 1914, have bravely struggled on under almost crushing loads.

Under this legislation the village and county newspapers will thrive at the expense of the journal of national circulation. This will make for provincialism and will naturally lead to intensification of local pride and prejudice.

There is already present a strong tendency for our vast country to split up along racial and purely artificial lines. The economic interests of one section of the country frequently differ radically from that of another. These economic differences have been composed in recent years by broad appeals that all sections work together, even at local sacrifice, for the good of the nation as a whole. These appeals have been carried by journals of national circulation, while the contrary appeals have been carried by local papers. If the local paper is left alone in its field it will state only the local aspect of every question. The only possible result of this course will be to strengthen the sectional and weaken the national consciousness of the individual. It is quite conceivable that this policy, if carried to its natural conclusion, will split the United States up into a half dozen sections, each section being envious of and more or less hostile to one or more of the other sections. This is sectionalism in its most virulent and mischievous form. Secessions and wars are among the plausible results of catering to sectionalism.

The fame of Lincoln rests not on his great heart, not on his eloquence, not on his emancipation of the slaves, but on his preservation of the union of the states. But for his success in this we should by now have several nations where there is but one. We should have a political system like that of Europe, with all its clashes of narrow national interests.

A careful attempt has been made to avoid the appearance of overstating the dangers to our country from the enforcement of this law. Readers who appreciate these dangers should use their influence to have this dangerous legislation annulled before it becomes operative.

Meterage for Chicago Again Recommended

Once again the meterage of Chicago's public water supply has been recommended. In a recent report the Chicago bureau of public efficiency recommended that a meter be placed on every water service line in the city; that meterage be inaugurated immediately and completed in ten years; and that the present misuse of water revenues for other corporate purposes be stopped. By adopting this program the city would, in the opinion of the bureau, save $1,600,000 by metering in the next ten years, and would avoid the expenditure of $15,000,000 additional on plant extensions.

Chicago now uses over 600,000,000 gals. of water per day, a per capita rate of 260 gals. The pumpage in 1916 was 14 per cent. greater than the entire supply of Greater New York, which has a population more than double that of Chicago.

It has been conservatively estimated by experts that 60 per cent. of the water pumped in Chicago is wasted. What a spectacle of municipal inefficiency! And who are to blame for this condition? The citizen and his representative in the city council. In truth, the alderman frowns on meterage because he knows the thought of metering his water supply is abhorrent to the Chicagoan. Representative government appears at its best and worst in Chicago—the aldermen give the people what the people think they want. The typical Chicago alderman has, for years, believed in meterage for every ward in the city but his own.

The average citizen thinks a meter will raise his water bill if he continues to use all the water he needs. Some think that meterage will be injurious to the public health, as it will lower the use of water to a point below the hygienic requirements. These are the stock objections which have been raised in every city in America for the past quarter century, when meterage has been seriously advocated. Both are groundless, as the experience of hundreds of cities has demonstrated.

In few cities, if any, have the uninformed people demanded the metering of the public water supply. This is something that must be administered to the protesting public by its better informed servants. How much longer will it take the Chicago council to meet this issue squarely and to decide it on economic grounds in the ultimate interest of the public?

The Farmer and Road Machinery

Ever since the American farmer started working out his poll tax on the road, he has looked upon road work as somewhat in his line. He has been willing to drag the roads, for a consideration, in some localities. The few dollars in cash he has been able to pick up on the road have helped to tide him over between seed time and harvest. For these reasons he has not always regarded with favor the purchase of road machinery by the township officials.

Now conditions have changed on the farm to such a degree that the farmer no longer seeks an opportunity to work on the road. Because of the shortage of farm labor, and the effort to produce a bumper crop each year, the farmer has his hands full with his farm work. This is a condition to which the manufacturers of road machinery are said to be reconciled. This will be the best year ever for the sale of road maintenance machinery.

Over Three Thousand

Since June, 1917, MUNICIPAL ENGINEERING has secured 3,487 (three thousand four hundred and eighty-seven) New, Cash, Paid-In-Advance subscribers.

And each and every one of these new subscriptions covers a period of one year and at the Regular $2 (per annum) Subscription Price of this publication. There is no camouflage about it. We received the Cash in each and every transaction.

In all of our twenty-eight years we have never made such a record. In June, 1917, we set a High Mark we would reach by June, 1918—and We Will Make It.

This issue of MUNICIPAL ENGINEERING will be read by More Engineers and Contractors (specializing in the Design and Construction of Streets, Roads, Sewers, Bridges, Waterworks extension, etc.) than ever before; and that number will be Increased each issue. Why? Because MUNICIPAL ENGINEERING is known as a thoroughly Reliable engineering magazine—everything in it is measured by the yardstick of Truth and Reliability before it is accepted for publication.

Details of the Design and Construction of the Water Supply of Camp Meade, Md., 79th National Army Division

By Morris Knowles, Pittsburgh, Pa., Mem. Am. Soc. C. E. and M. Am. Inst. Cons. Engs., Supervising Engineer, Camp Meade.

Camp Meade, the cantonment for the 79th National Army Division, is located between Baltimore and Washington, near Admiral, Md. It is situated between the Pennsylvania and the Baltimore & Ohio railroads, and is also reached by the Washington, Baltimore & Annapolis Electric Railway, and is sufficiently large to care for about 50,000 troops. In the building of these "army cities" one of the prime considerations was the sanitary and health conditions, so that the water supply problem was one which gained immediate attention and exhaustive investigation.

Temporary and Permanent Supplies

In considering a water supply for a cantonment located like Camp Meade, or almost any other cantonment, there are two distinct and separate supplies which have to be kept in mind; one of a temporary nature, which must be made available in a short time, for immediate use during the construction period, and the permanent supply for the use of the cantonment.

The Temporary Supply

The temporary supply may be of such a nature that it can be later incorporated into the final system, or it may be of such a nature that it is not adapted to use with the system which is finally built.

At Camp Meade the temporary supply was procured from some of the original farm wells and deep wells driven at various points on the reservation, which were located with the idea in view of later tying them into the distribution system for the camp. They are all deep wells and so situated and planned that in an emergency they can furnish a limited supply of water into the permanent system.

The Permanent Supply

In designing the regular system, a complete study was made of all the rainfall and stream flow data, procurable from the U. S. G. S. and Maryland State Department of Health and also a sanitary survey of the watershed of the little Patuxent River. With these data at hand it was decided to take the supply from the Little Patuxent River near Welch's Bridge, which has a dry weather flow of 4 M. G. D. and an average flow of 112 M. G. D.

The water of the river is generally turbid and carries considerable quantities of colloidal clay. It is also somewhat polluted from the habitations on the drainage area, which generally dispose of their wastes in pits and cesspools; although there are a few institutions and villages which have treatment works and run their effluent into the stream. These conditions made coagulation and filtration necessary and the lime-alum treatment, with rapid sand filters, was finally adopted, the water being chlorinated after leaving the filters.

VIEWS SHOWING CONSTRUCTION OF CAMP MEADE, MD., WATER SUPPLY WORKS.

Left to Right: Two 12-in. Wood Stave Lines Connecting Low Service Pump Station and Filter Plant—Bypass Flume at Patuxent Dam and Intake—High Lift Pump Station Showing Location, Pumps and Motors—General View of Filter Plant Showing Clear Wells, Sedimentation Basins and Filter and Alum Tanks Before Construction of Superstructure—Pipe Connections, High Lift Pump Station—Construction of Storage Reservoirs—Dam and Intake on Little Patuxent River—Dam Site and Intake About Completed—Construction of Dam and Intake.

Essential Elements in the Design.

The system as finally designed, under the direction of Mr. W. H. C. Ramsey, Division Engineer, in charge of Water and Electric Systems, consists of a diversion dam and intake, leading to a set of low-lift pumps, which pump the water to the sedimentation basins. There it is treated and run by gravity through the filters and over to a set of high lift pumps, which feed into the distribution system and also supply the storage tanks, which act as equalizers on the system and as an emergency supply for fire protection. Smith, Hauser and McIsaac, Inc., were the general contractors, for this work as well as the entire Cantonment work.

Construction Details and Methods

Dam. The dam at the intake is log crib construction, filled with stone and gravel, and is 7 ft. higher than creek bottom. Under the dam, at the creek level, there are two rectangular wooden blow-offs, 18 in. high by 5 ft. wide, with sluice gates on the up-stream face of the dam.

Intake. The intake is of reinforced concrete and is placed with its lower end 6 ft. up-stream from the face of the dam and with one side parallel to the creek and in line with the edge of the stream. It is designed to take the water from the top of the stream rather than from the creek bed, in order to prevent the drawing of sand and debris into the intake chamber during low water. It is constructed with three chambers, two of which are catch pits for sand and gravel; and third a side chamber which forms the suction chamber.

The water enters the intake over a weir wall set 9 in. lower than the crest of the dam and flows over a set of bar screens placed as a cover over the two catch pits. By reason of the stilling action of the intake, any supsended matter is dropped into this up-stream catch pit. The water required for the pump suction passes through this bar screen into the catch pit, thence through two sets of vertical screens made of No. 10 copper and ¼-in. mesh into the suction chamber. Each of the catch pits is provided with a 12-in. drain pipe passing through the log crib dam.

The weir wall of the first catch pit, over which the water first enters, is provided with grooves for the reception of stop planks, which are so placed to prevent the water from entering the intake when it is necessary to work at the foot valves or in the intake. On the down-stream wall of the second catch pit another groove is placed for the reception of stop planks which are to be changed from day to day as the level of the water over the crest of the dam varies. These planks are to be regulated to such height that the water will pass over them at a depth of approximately 1 or 2 ins. When operated in this manner the depth of water on the crest of the dam is considerably greater than that flowing over the stop planks, thus insuring a far greater velocity of water down-stream than through the intake, and debris will thus be carried over the crest of the dam by reason of this velocity.

Lime Treating Plant. Contiguous to the concrete intake is a lime treating and storage plant. This equipment consists of two tanks equipped with motor driven stirring devices, and a small motor-driven lime mixing chamber and standard orifice feed tank. The lime is carried into the suction chamber of the intake and is discharged between the two pump suctions, on a level with the foot valves, and just inside the fine mesh screens.

Low Lift Pumping Station. The low lift pumping station is located close to the intake and in order to keep the suction lift low it was found necessary to place the pumps in a pit which has watertight concrete walls and floor. The pumps are belt connected, motor-driven, the motors being placed on a floor about 7 ft. above the pumps. The installation consists of two 1,000-g.p.m. and one 750-g.p.m. single-stage centrifugal pumps.

The 8-in. discharge lines are manifolded immediately into two 14-in. mains cross connected by a 12-in. gated pipe. After about 100 ft. of 14-in. mains the line is reduced to two 12-in. wood stave mains 3,260 ft. long, which lead to the filtration plant about 80 ft. higher.

Filter Plant. The filter plant consists of two 100,000 gal. wooden tanks used as sedimentation basins and six filter tubs with a capacity of 500,000 gals. per day each. The filter bed consists of 15 ins. of coarse gravel and 24 ins. of sand. The filter tubs are of the high velocity wash type, requiring approximately 15 gals. per square foot of filter area per minute.

The super-structure is one-story high over the northern end of the building and two stories over the southern end. Two alum tanks are located in the second story. These tanks are equipped with three orifice feed tanks, two discharging through separate lead lines into their individual sedimentation tanks and the third connected by lead line to the influent main just ahead of the filters.

Chlorination. Two solution feed type liquid chlorine machines are installed in the filter house and discharge into the effluent main.

Clear Wells. The clear wells are about 135 ft. west of the filter plant. There are two of these tanks similar to the sedimentation tanks and with a capacity of 100,000 gals. each.

High Lift Pumping Station. The high lift pumping station is located just west of the clear water tanks, and contains two 1,000-g.p.m. and one 750-g.p.m., two-stage, centrifugal, belt-connected, motor-driven pumps, designed to operate against a head of 250 ft. The discharge from these pumps is carried through two 14-in. mains, cross connected by a 12-in. gated main. These 14-in. mains are reduced to 12 in. shortly after leaving the station, which mains lead to the distribution system and eventually to the four 100,000-gal. redwood tanks, located on the northerly corner of the reservation. These tanks serve a double purpose—to maintain a uniform pressure in the system and to act as a reserve for fire protection.

Camp Meade is one of the cantonments where so elaborate a system of water works is required, including, as it does, a complete purification equipment. Although a surface stream is used, the recent health reports show that the morbidity and mortality records are lower here than at other camps, with practically a total absence of any water-borne diseases.

Military Roads Essential—Ten Billions of Farm Products and Only Five Per Cent. of Good Roads

By F. A. Churchill, Conneaut, Ohio

At variance with public understanding, as it may be, the responsible heads of cabinets at Washington are thoroughly convinced that road building is vitally essential to the successful prosecution of the war as a means of transportation of supplies which cannot be handled by the railroads. Secretary Baker of the War Department, and Secretary Redfield of the Department of Commerce, have declared this necessity in unqualified terms. It is chiefly because of the now generally condemned Order No. 2, issued by Judge Lovett of the Board of Priority, that public belief in the undesirability of road building during the war has arisen. Fortunately, this priority order has been lifted for the present at least.

Early Hysteria Is Passing

It is true that at the outbreak of the war, officials in Washington and the Governors of certain states, became hysterical and advised total suspension of road building; but that was an exhibition of mental unbalance due to temporary paralysis of the sense of proportion.

When war was declared the shock was too great for some

official minds at Washington and elsewhere to function properly. The magnitude and complexity of the problems confronted led to hasty judgments and impulsive action. Without due consideration, and on the spur of the moment, unwise advice was given, and, unfortunately, in some instances that advice was accepted at its face value and acted upon by state, county and municipal authorities.

Now, however, such men as Secretaries Baker and Redfield, and the United States Chamber of Commerce and leading magazines and newspapers see the folly of suspending road building, and gradually the public is getting a more clarified vision of the intimate relations betwen good roads and war supplies.

One of the most regrettable and harmful effects of the early spasm of irrationality on the part of officialdom is noted in the attitude assumed toward paving bonds by investment houses here and there. Some of these houses, under the mistaken impression that they were aiding in the conservation of energy and money needed for war purposes, shut down on investments in bonds issued for road improvements. This action hampers some communities that have taken a sane view of the situation and have gone ahead with road-building projects.

Not long ago President Wilson said: "It is perfectly obvious that you have got to have an intricate and perfect network of roads throughout the length and breadth of this great continent before you will have released the energies of America." The allies are depending on the energies of America. Unless they are released and given full play there is grave danger of losing the war. Road construction is, therefore, imperatively requisite to national defense and security.

War Department Demands Better Roads

One of the most encouraging signs of the times in respect of road building is the urgent demand for better roads that is issuing from the War Department. Secretary Baker is echoing the voice of discerning men of influence in all parts of the country.

Reflection has shown the public the fallacious nature of the policy of increasing production and at the same time curtailing transportation facilities. Men who are in touch with practical conditions understand clearly that for transportation purposes no road is better than its worst section. A half mile of bad road fixes the maximum load that can be hauled over the road, although there may be 200 miles of good pavement elsewhere on the route.

The building of continuous through roads is imperatively essential to motor truck traffic. Main roads everywhere should have gaps closed and they should be completed from logical starting point to logical terminals. Lateral feeders of main roads should also be improved in such manner as to bear heavy traffic without wearing out in a few years.

Only 5 Per Cent of U. S. Roads Improved.

Let it be borne in mind that only about 5% of the 2,400,000 miles of highways in the United States are what may be called suitably improved. Yet over these roads must be hauled the products of 6,361,502 farms, comprising 878,798,325 acres of land, in 30,000 townships in 48 states. These products in 1915 were worth $10,501,686,375, and 12,659,208 persons were engaged in the production.

In view of the foregoing facts in these times of need, when supplies are vitally essential and means of transportation are notoriously inadequate, is it unreasonable to demand energetic prosecution of road-building enterprise?

Military Roads Must Be Dependable

Federal and state authorities are beginning to realize the vital necessity for dependable roads for military purposes. Types of road which serve ordinary traffic purposes will not do, especially for roads over which the enormous 10-ton and 15-ton motor truck traffic at camps and cantonments must go. Therefore, roads leading to Camp Benjamin Harrison, near Indianapolis; Camp Johnston, near Jacksonville, Fla.; Camp McClellan, Anniston, Ala.; Camp Grant, Rockford, Ill.; Camp Dodge, Des Moines, Iowa; Camp Sherman, Chillicothe, Ohio, etc., have been paved with wire-cut lug brick. In some of the cantonments the main streets also are paved with brick, because the enormous weight and volume of traffic demands a high type and durable smooth-surface pavement.

Secretary Redfield, of the Department of Commerce, in a published interview, tells how the supposedly good improved roads of New Jersey, leading to the cantonment at Wrightstown, were torn to pieces in a very short time after the camp was established.

Trucks weighing 10 tons and 12 tons each, traveling 20 miles an hour, and passing at intervals of 40 seconds, as reported from some of the cantonments, require roads that can stand not only tremendous loads but the most severe abrasion tests as well. Roads which require constant maintenance and frequent repairs in order to keep them serviceable are not suited for military purposes. Surfaces which wear or pit or ravel or disintegrate under heavy traffic stresses cannot qualify for military service.

Extraordinary conditions prevail in times of war. Vast quantities of materials must be transported by highways. Roads for assembling and distributing food stuffs are as essentially military as roads over which munitions must pass. An army must be fed as well as equipped. The product of 6,000,000 farms cannot be made available without highways serviceable for heavy hauling 365 days in the year.

Every Road Now a Military Road.

The summation of the whole matter is this: Every road over which supplies of any kind must be hauled by wagon or by auto truck is a military road in times like these. Improvements which will give these roads the highest efficiency in facilitating quick transportation of supplies in maximum quantities are a military necessity. The essential and indispensable qualities of military highways are smooth surfaces and great durability.

Traffic conditions have been revolutionized. Nothing except the highest type of road can withstand the enormous loads and abrasive stresses of the kind of traffic developed by the war—a traffic which will continue in kind and increase in volume, in response to commercial requirements, for an indefinite period after the war shall have ended. The era of light traffic is gone forever.

Hydraulic Conversion Tables and Convenient Equivalents

Here is a Water Supply Paper (No. 425-C), issued by the United States Geological Survey, of more than local interest. It is entitled: Hydraulic Conversion Tables and Convenient Equivalents. It is a reprint of pp. 71-94 of Contributions to the Hydrology of the United States, 1917. The convenient equivalents cover, length, surface, volume, hydraulics, miscellaneous and map scales.

Using Portable Air Equipment on Brick Pavement Repairs

The use of portable air compressors and air hammers for use in brick pavement repair for cutting out joints and cleaning brick is well established in Cleveland and vicinity. There are 15 or 20 outfits of this sort in use by contractors in and near Cleveland. The county engineer of Cuyahoga County has two outfits, and several contractors have two or more. With one of these machines one man can clean as many birck as five men by hand, and in cutting joints one man can do as much as ten men by hand. This is the observation of D. Moomaw, Road Engineer of Cuyahoga County, Cleveland.

PAVEMENT DESIGN AND CONSTRUCTION

Data on Operation of Asphalt Mixing Plant Owned by City of Worcester, Mass.

By Albert T. Rhodes, Commissioner Street Department, Worcester, Mass.

The Cummer Mixing Plant, owned by the street department of the city of Worcester, is producing for us an average amount of about 100 sq. yds. of 2-in. Topeka top per hour of operation. This we feel gives a better idea of the production than the so-called daily production, because some people are basing their output on a 10-hour day and some only on an 8-hour day; but we find under normal conditions that our average output is about 100 sq. yds. per hour, of 2-in. top.

Organization and Duties of Force

The plant is very conveniently situated, the materials coming in on a platform at the same level as the kettles, thus bringing the heavy materials at a convenient level for disposition into the plant. The plant is operated by one plant foreman, who looks after the grading of the materials on screen tests and who sets the mix; one fireman, who looks after both the heating of the large drying drum and the fires under the asphalt kettles; one dipper man, who fills the asphalt scales with their proper weight of bitumen; one man who looks after the mixing box, seeing that the mixture is at its proper consistency and dumping it into trucks; one man on sand and screening box scales, who weighs out the proper amount of mixed sand and traprock screenings and puts same into the mixing boxes; one man on ground lime rock filler; two sand wheelers; two wheelers of traprock screenings; one man on the hopper into which same are delivered; and one man on the bucket elevator. One spare man during the day fills up the asphalt kettles and acts as an emergency man, in case of any difficulty occuring at the plant, or the necessity arises for an extra man at any point during the operation.

Duties of Night Watchmen

In addition to the above force there are kept two men as watchmen over this yard. One arrives at 4 o'clock in the afternoon and looks after the cooling down of the machine. It is absolutely necessary to operate the drum for a very considerable time after shutting down the plant, in order not to warp it out of shape. This is on account of heat being concentrated on one side of the drum while it is cooling on the other. This man looks after this cooling-off process and is relieved at 12 o'clock midnight by another watchman, who starts the fires early in the morning to get the plant and the asphalt for the mixture warmed up for the other workmen, who arrive at 7 or 8 o'clock, as the case may be.

Handling Raw Materials and Operation of Plant

The sand and traprock screenings come in on a platform back of the machine and are wheeled in wheel barrows into a hopper, which delivers to the bucket chain. It has been found necessary to keep a man at the hopper and also at the bucket chain, on account of the mixture of sand and screenings standing almost perpendicularly, without falling either down into the hopper or into the bucket chain. The mixture of sand and traprock screenings is delivered from the bucket chain into the drying drum, from which, after being thoroughly dried and the fine dust driven off by a suction fan, it is delivered to another bucket conveyor, which conveys the dried material to a hopper over the weighing bin, into which it is taken in the proper quantity from the hopper above. When the proper weight of sand and screenings has been delivered into the weighing box, it is from there delivered into the mixing box, at which time the proper amount of asphalt by weight is delivered into the asphalt weighing box from the asphalt kettles, and the paddles quickly churn the mixture to the proper consistency, from which it is dropped into the waiting trucks or wagons beneath and carted to the job. Two asphalt kettles are filled with 750 gals. each, and from time to time during the day more is added, bringing the amount up to about 1,000 gals. each.

The Mixed Material

The mixed material is drawn to the place at which it is to be used in either trucks or carts, which have been thoroughly greased inside with crude oil, this crude oil keeping the mixture from sticking to the sides of the vehicle. The mixture

VIEWS OF ASPHALT MIXING PLANT OWNED AND OPERATED BY CITY OF WORCESTER, MASS.

used is composed of the following ingredients and in proportions as indicated:

55 lbs. asphalt to 500 lbs. sand and screenings (½ of each).
35 lbs. filler (ground marble dust).

Applying the Mixed Material

The number of men on the job to receive the top and apply same is composed of a foreman, three rakers, two tampers, two ironers, five shovellers, one finisher, a watchman, together with a tandem roller and engineer. Three trucks are used for transportation within city limits.

The material is dumped on a prepared and thoroughly rolled base of old macadam, or a concrete base, whichever may be used. It is shoveled from the load as dumped, spread by rakes to the proper thickness and grade, and tamped next to the railroad tracks and curbs by hand tampers. It is allowed to cool to the proper condition in which it will take a tandem roller without sticking to the wheels, after which

the roller is passed over the top surface. If the roller is not provided with proper sprinkling devices for water sprinkling, either ground lime stone dust or common Portland cement is broomed on the top surface to keep the asphalt from sticking to the roller wheels.

Rolling

It is given a thorough rolling by a 6-ton tandem roller, followed by a heavier roller, weighing anywhere from 10 to 15 tons. The edges at the curb and at the railroad tracks are painted with a composition of asphalt, such as is used in the mixture, and following the tamping and rolling an iron heated in an open brazier is used to iron the surface at the curb, or at the railroad tracks, to a proper top finish, to fill in all the voids and make a proper tight job at these points.

The rolling is done as far as possible longitudinally and transversally. If it is not possible to roll transversally in the proper manner, the "S" type of rolling is followed and then reversed in the manner of a figure 8. In this way the cross rolling is accomplished without running against the curbs, in which case on the reverse motion of the roller the probability is that a hole would be formed in the soft pavement. The finished product gives a clean, sanitary, reasonably durable top surface, which can be flushed in the proper manner, similar to any hard top pavement.

Cost

The cost in the city of Worcester during the season of 1917 varied from $1.14 to $1.33 per sq. yd., which included the preparing of the subgrade, rolling it and the complete 2-in. topping. This price is extremely high, however, on account of the fact that the streets thus treated were old macadam streets, on which one layer after another of macadam had been applied, bringing the existing surface at the time of this work very much above the proper grade and necessitating the carting away of a very considerable quantity of material, in order to get the finished subgrade down to the proper point to take the 2-in. topping.

Specifications for Asphalt-on-Concrete-Base Road Construction

By D. T. Pierce, Executive Assistant, Barber Asphalt Paving Co., Philadelphia, Pa.

Recent reports of contracts awarded for the construction of mixed-top asphalt roads on a concrete base leave no doubt as to the increasing popularity of this type. The reports are taken at random from the daily records of the Barber Asphalt Paving Co. and represent large yardages in Pennsylvania, Kentucky, Mississippi, West Virginia, Oklahoma, Ohio, Indiana, Illinois, Iowa and other states, this brief list indicating wide distribution rather than the number of communities laying mixed method roads with natural asphalt on a Portland cement concrete base. In addition to the states actually building this type of road, several highway departments are turning to it, partly as a result of high costs of other types and partly as a result of the demonstration of its durability now covering a period of many years.

Advantages of the Type

Owing to the moderate cost of the base and the rapidity with which it can be laid and utilized, the type offers a short cut to a highly essential requirement of modern highways, namely, the carrying of increasing weight of traffic. The ease with which an asphaltic top may be kept in repair without disturbing the concrete base is another advantage claimed for this type of road.

The combination road described does not mean a concrete road with a superficial covering of stone chips bound with asphalt or tar, for the wearing surface includes advantages not found in these very thin tops or carpet coatings. It is not only designed to withstand years of traffic, but must be sufficiently thick and impervious to protect the concrete from destructive changes in moisture content and temperature, particularly the former. Practical experience extending over a long period of years has demonstrated that a substantial 2-in. asphaltic surface will prevent the upheaval or disintegration of concrete, as extreme expansion and contraction do not occur.

A Good Specification

It could easily have been foretold, and now experience is demonstrating, that durable asphaltic wearing surfaces can not be built unless careful attention is given to the grading or proportioning of the aggregate. To specify simply a 65-35 per cent. mixture of stone and sand will not make a durable wearing surface; it would not even make good close binder. One good specification under which a large yardage of successful work has been done is the following:

Mineral Aggregate—The mineral aggregate shall consist of sand, crushed trap rock, hard limestone or other stone of equal quality, free from weathered and dirty particles, and a finely powdered mineral filler, all of which shall meet the approval of the engineer.

Sand—The sand shall be a natural bank or river sand, consisting of hard and angular, but not necessarily sharp, grains, all of which will pass a 10-mesh screen and not contain more than 3 per cent. of clay or loam. On sifting, at least 15 per cent. shall be retained on a 30-mesh screen, and at least 22 per cent. shall pass an 80-mesh and be retained on a 200-mesh screen.

VIEW OF ASPHALT-ON-CONCRETE BASE ROAD BUILT ON BUSTLETON AVE., BY PHILADELPHIA BUREAU OF HIGHWAYS.

Stone—The crushed trap rock shall all pass a screen of two (2) meshes to the lineal inch and all be retained on a 10-mesh screen, or the run of crusher trap rock can be used, provided the portion passing the 10-mesh screen is of suitable grading to serve as sand and filler, in which event only sufficient sand and filler will be added to insure the proper proportion of sand and filler in the mineral aggregate.

Filler—If the screenings do not contain sufficient 200-mesh particles, they shall be supplied by the addition of a suitable amount of ground limestone, or any other mineral matter (or Portland cement) of sufficient density to produce a powder having a volume of weight when ultimately compacted of at least 90 lbs. to the cubic foot. It shall be so fine that at least 75 per cent. shall pass a 200-mesh screen.

Combining Materials—The sand and stone complying with the above specifications shall be heated in a suitable plant to a temperature of from 300 to 350 degrees F., and shall be combined and thoroughly mixed while hot by machinery, in such proportions that the finished mixture shall contain not more

than from 8 to 22 per cent. of aggregate passing a 4-mesh and retained on a 10-mesh screen and less than 10 per cent passing a 2-mesh and retained on a 4-mesh screen.

Philadelphia Bureau of Highways Specification

The specification used by the Bureau of Highways of Philadelphia is even simpler than the above. It provides:

"The stone shall consist of sound, hard, crushed trap rock, with a coefficient of wear of not less than 15, or limestone, with a coefficient of wear of not less than 10, free from dust and passing a ¾-in. ring.

"The surface mixture shall consist of asphalt cement, crushed stone, sand and Portland cement or stone dust, so that the resulting mixture will contain the several materials in average proportions of the whole mixture, as follows:

Bitumen	7 to 9 per cent.
Dust or Portland cement	12 to 14 per cent.
Sand, coarse or fine	35 to 40 per cent.
Crushed stone	40 to 50 per cent.

"The proportions shall be fixed within the limits designated by and at the discretion of the engineer. The proportion of fine sand passing a 200-mesh sieve shall not exceed 2½ per cent. of the total mixture."

The Philadelphia Highway Bureau has jurisdiction over many miles of roads so remote from the thickly populated sections of the city as to bring them within the country road class. Their improvement, however, has invariably resulted in increased traffic, thus subjecting them to thorough test. The bureau has found the combination road very satisfactory and economical, and it is now among the city's standard types for heavy traffic roads.

Typical Philadelphia Road of This Type

A typical Philadelphia combination road is shown in the accompanying picture of Bustleton avenue, which, at the section shown, runs through an agricultural district. This road consists of a 4-in. concrete base and curbs and a 2-in. asphaltic concrete top. It was finished in January, 1916, unit costs as given by the highway bureau being as follows:

Portland cement concrete base	$4.36 per cu. yd.
Asphalt paint coat applied to surface of concrete base	.05 per sq. yd.
Bituminous surface	.60 per sq. yd.

These prices mean about $11,000 a mile for a 16-ft. road.

The wearing surfaces of these roads have the slightly yielding or resilient quality required by both horse and motor traffic. Should a new surface be required after years of traffic, the city, at the price given above, would obtain practically a new road for less than $6,000 a mile. This fact emphasizes the value of a concrete base as a permanent and economical investment, as it is a constant support to the wearing surface and calculated to last indefinitely. Incidentally, the Philadelphia Bureau has experimented with practically every type of highway in the form of so-called test roads, and the fact that preference is given the combination road for heavy traffic thoroughfares is strong endorsement of the type.

Careless Construction Causes Early Failure of a Brick Pavement

By Harlan H. Edwards, Highway Engineer, 2831 Washington Blvd., Chicago, Ill.

Poor design, indifferent inspection, and careless construction have caused considerable waste of money by shortening the life of many of our brick pavements built by local authorities without competent engineering supervision. In and near most municipalities may be found excellent examples of the waste of public funds caused by the deliberate disregard of the principles of good paving practice and the apparent absence of common sense and good judgment in those responsible for the work. The failures of these pavements have afforded opportunity to unscrupulous politicians or competing material men to bring discredit upon the good name of durable paving material which has been damaged or destroyed by poor workmanship. Such an example is found on the road running south from Danville, Ill. to Lyons.

Grouted Brick Pavement

This road was surfaced with a grouted brick pavement scarcely five years ago, yet now, in spots aggregating about 30% of the surface, the grouted joints have failed, causing spots of crushed brick, crushed grout, and a section of pavement some 1,000 ft. in length wherein the grout filler has failed entirely. There is little excuse for such an occurrence, yet it emphasises the principle that a little cement poorly placed is much worse than no cement at all.

Design of Pavement

As constructed, the brick road is 12 ft. wide, laid on a 4-in. concrete foundation with a 6-in. curb, having the 4-in. Danville wire-cut-lug pavers laid on a 1½-in. sand cushion.

BRICK PAVEMENT, DANVILLE, ILL. WHERE CEMENT FILLER FAILED WIDTH OF PAVEMENT, BUT WIRE-CUT-LUG BRICK REMAINED PRACTICALLY PERFECT.

Poured expansion joints were placed every 50 ft. through the brick slab. Part of the work was done during cold weather, which may account for the entire failure of the grout in one section.

Proper Construction of a Grouted Pavement

In any grouted pavement it is essential that the joints be free from sand or other foreign material, and be filled the entire depth of the brick with the cement grout, thus cementing the separate brick into a solid slab. Then, as the temperature rises and falls, and expansion or contraction takes place, the stresses set up will be equally distributed over the entire depth of the brick. On this work, however, the joints were filled in places but 1 in. or less at the top, thus bringing the stress from expansion entirely upon this top section. This force in some places was great enough to shatter or pop-off the top of the brick or crush the cement filler, destroying the bond, and ultimately subjecting the entire pavement to destruction.

Failure in Spots

In this case, as in most pavements, the failure did not come in the entire pavement, but rather occurred in spots where the grout had been carelessly applied or was of a too thick consistency, so that it bridged over the joints and failed

to penetrate the full depth. This trouble was also noticed where in rolling the brick surface the sand had worked up between the brick 2 or 3 ins., preventing the further penetration of the grout.

Most Failures at Expansion Joints

The greater number of the failures of the grouted joints, however, started in the rows of brick adjacent to the expansion joints, and spread for the greatest distance in both directions along the wheel-traveled way. Since at each expansion joint the adjacent brick were not solidly supported by the sand cushion, and were rigidly held in place only by the adhesive power of the grout on one side, the impact and longitudinal thrust of horse and motor traffic constituted a turning force acting on and tending to push the top of the brick into the space occupied by the elastic or plastic expansion joint. This soon broke the bond in the grouted joint, and allowed water to penetrate and saturate the sand cushion.

PAVEMENT FAILURE DUE TO CARELESS CONSTRUCTION.

Greatest Number of Failures Started at Expansion Joints and Spread Along Wheel Track. Impact of Heavy Wheels Over Uneven Surface Resulted in Ruts and Crushed Brick.

The initial step being thus accomplished, the failure of the succeeding joints in the pavement was hastened by the combined action of traffic and the water in the sand cushion. Its lubricating qualities, combined with the vibration from traffic, caused the sand to shift and compact, leaving a hollow space under this part of the slab. As traffic moved over this and adjoining sections, great shearing and tensile stresses were put upon the grouted joints, ultimately causing their failure and consequently increasing the area of failure, especially along the wheel-track. More wear was caused at these spots by the hammer-like impact of heavy wheels over the uneven surface, ultimately resulting in ruts, bumps, and crushed brick at each place. This destructive action was undoubtedly hastened by the freezing and consequent expansion of the water in the sand cushion.

Uniform Disintegration of Grout

In one section, however, opportunity was not given for this to happen, for the grout shattered or disintegrated uniformly in the entire pavement for a space of about 1,000 ft. This, then, produced a condition similar to a sand-filled brick pavement. In a sand-filled brick pavement straight wire-cut or repressed brick are used, leaving but a small, narrow joint, while here the wide joints made by the wire-cut-lug brick afford an excellent opportunity for heavy wagons, etc. to break off and cobble the edges of the brick. It is interesting to note here, however, that in this section of the pavement the brick have remained practically perfect even though the cement grout filler has failed completely.

Competent and Constant Supervision Requisite

Such failures as these illustrate not only what has happened but also what is very likely to happen to grouted brick pavements designed and built without constant and competent supervision. Although no pavement is more permanent than one built with uniformly hard and tough vitrified paving brick, properly placed on a solid foundation, still no pavement is much more uncomfortable to ride over than these same brick pavements carelessly put in and subsequently taken up to repair or install pipes and wires underneath. It is not the intention of the writer to condemn sand cushion brick pavements in which the joints are filled with sand or bituminous material, for some of our best old pavements are those of the sand-filled type; but rather to point out that no matter how perfect the brick or cement may be, if careless construction be permitted, failure of the wearing surface will almost invariably occur at an early period, thus bringing to mind again the fact that a little cement poorly placed is much worse than no cement at all.

Monolithic Construction Eliminates Many Causes of Failure

The introduction of the monolithic and semi-monolithic ideas in brick pavement construction has eliminated many causes of failure by affording a rigid foundation for each brick, yet a large number of our cities continue to construct the sand cushion grouted brick pavements under the "supervision" of non-technical political appointees, and then condemn the materials used when after three or four years of use failure begins to occur.

Approved Practice in the Construction of Granite Block Pavements

By Clarence D. Pollock, of Pollock and Taber, Consulting Engineers, Park Row Building, New York City.

The present standard granite paving block has a width of from 3½ to 4½ in., a length of 8 in. to 12 in. and a depth of 4¾ in. to 5¼ in.

Standard Blocks

Further requirements are that "the paving blocks shall be of medium grained granite, showing an even distribution of constituent materials, of uniform quality, structure and texture, without seams, scales or disintegration, free from an excess of mica or feldspar. The blocks shall be so dressed that the faces will be approximately rectangular in shape and the ends and sides sufficiently smooth to permit the blocks to be laid with joints not exceeding ½ in. in width at the top, and for 1 in. downward therefrom, and not exceeding 1 in. in width at any other part of the joint. The top surface of the block shall be so cut that there will be no depressions measuring more than ⅜ in. from a straight edge laid in any direction on the top and parallel to the general surface thereof."

The above requirements are in the specifications of the American Society of Municipal Improvements, and are now in very general use.

Variations from Standard

Of course, there are numerous exceptions to these standard blocks. A few cities specify a block with a length of 6 to 10 ft. with a top surface or head cut so that there will be no depressions measuring more than ¼ in. and to lay to a joint not exceeding ⅜ in. Such a specification may produce a pavement with possibly 10 per cent. of the joints better than with the standard specifications, but as the area of the head of the block is smaller and consequently more blocks are required to the square yard, it adds considerable to the cost of the pavement and the writer is of the opinion that this extra expense is not warranted except in rare instances.

Joint Thickness

When standard blocks are well cut and properly paved under the specifications that the joints shall not exceed ½ in. in width, something like 75 per cent. of the joints will comply with the more rigid specification and it would seem unnecessary to spend an additional 40 or 50 cents per square yard to have possibly another 10 per cent. of the joints a little closer. Such a requirement is practically as rigid as that for cut stone

joints in building construction. It is not a practical proposition to split out paving blocks so that a ⅜ in. joint can be rigidly complied with. If a cement grout filler is used such a joint is not necessary, and it is very questionable if it is ever necessary with even a bituminous filler. It certainly is not desirable to specify something which it is not practicable to obtain.

Other Variations from Standard.

Other variations from the standard are so-called 4 in. blocks, Durax blocks, and the like. It is sometimes necessary, because of freight charges, etc., to use shallow blocks, or else use a pavement which is less durable than granite blocks. This condition is more likely to prevail on road work and in inland cities where there is a rail haul.

Then there is another condition which requires a shallow block, and that is where the traffic conditions have changed so much that it is necessary to use granite to replace a lighter material, and yet it is desired to utilize the old concrete foundation. For such a condition a resurfacing block is made which has a depth of 3½ to 4 in. It is preferable to lay such a block upon a cement mortar cushion, especially if the traffic is heavy.

Laying the Pavement

The standard block when properly cut and laid is the most suitable for general conditions. This pavement is laid in various ways. In cities and localities where it is possible to block off traffic for a sufficient time to permit the use of a cement grout filler, it is usually laid with such a filler, and if the traffic is heavy enough to warrant the expense, it is often laid on a cement mortar cushion mixed in the proportion of one part of cement to three or often four parts of sand. This makes a very solid and durable pavement when properly done. The blocks should be sorted and laid in courses so that blocks as nearly as possible of the same width are in a course and the blocks should be paved with close end or longitudinal joints, the courses running transversely from curb to curb. The transverse joints should be as close as possible and yet keep straight courses. The longitudinal joints should be broken by a lap of at least 3 inches.

Ramming

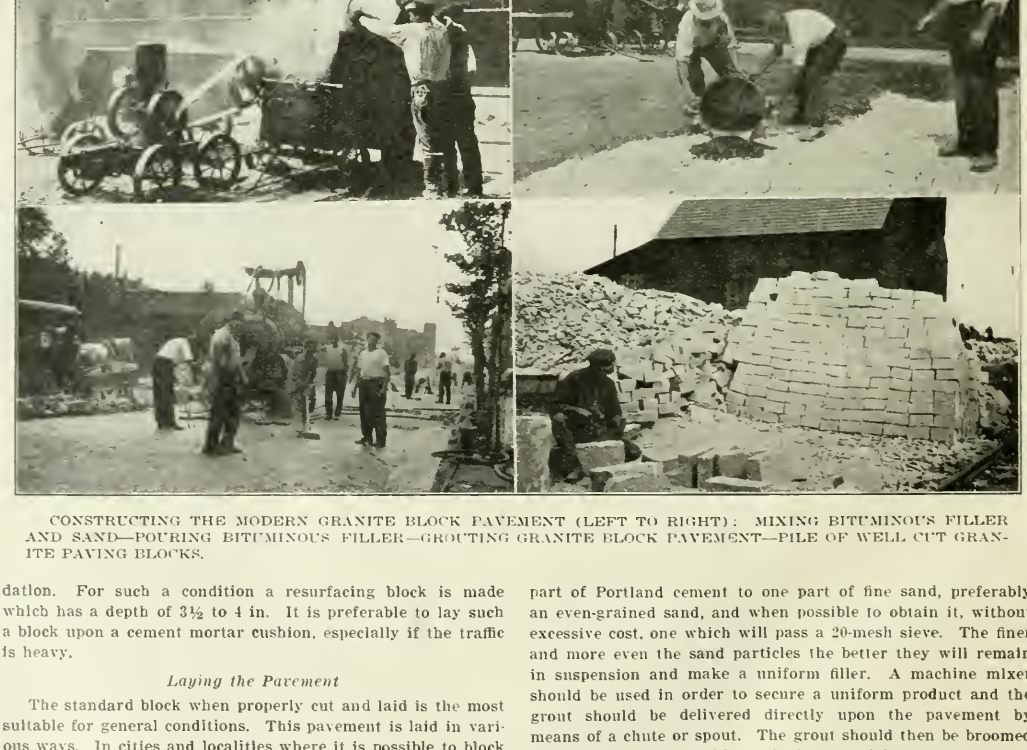
The pavement should be thoroughly rammed and all poorly bedded blocks raised and back rammed until the blocks are all well and evenly bedded and the surface of the pavement is true and even to the grade and crown of the street. It is advisable to use no sand or gravel in the joints. Proper ramming will cause the blocks to sink into the cushion so that a little ridge of the cushion will separate the blocks and be sufficient to hold them until the filler is poured, provided wheeling and other traffic is not permitted over the surface.

Cement Grout Filler

Now the pavement is ready for the filler. If it is to be a cement grout filler, it should be mixed in the proportion of one part of Portland cement to one part of fine sand, preferably an even-grained sand, and when possible to obtain it, without excessive cost, one which will pass a 20-mesh sieve. The finer and more even the sand particles the better they will remain in suspension and make a uniform filler. A machine mixer should be used in order to secure a uniform product and the grout should be delivered directly upon the pavement by means of a chute or spout. The grout should then be broomed into the joints thoroughly until they stand full and flush with the surface of the blocks, but a surplus should not be left over the surface. The wear should come upon the granite. The traffic will then wear down any small irregularities in the heads of the blocks.

Bituminous Filler

When a bituminous filler is used the best practice is to add a fine hot sand and mix it before pouring the joints. A straight coal tar pitch is too susceptible to temperature



CONSTRUCTING THE MODERN GRANITE BLOCK PAVEMENT (LEFT TO RIGHT): MIXING BITUMINOUS FILLER AND SAND—POURING BITUMINOUS FILLER—GROUTING GRANITE BLOCK PAVEMENT—PILE OF WELL CUT GRANITE PAVING BLOCKS.

changes to be used in this climate, but a mixture of one part of asphalt with five parts of coal tar pitch gives good results, as does also an asphalt filler. With either of these there should be added not to exceed 50 per cent. by volume of fine sand similar to that used in a cement grout filler. The amount of sand added should be at least 35 per cent. The sand should be mixed into the hot bituminous material and then drawn off into wheelbarrows or the like and dumped at once upon the pavement. It can then be worked into the joints by means of hoes or the like. When the joints are thoroughly filled so that they stand up flush with the surface of the blocks, then a small amount of sand should be spread over the surface. This will prevent traffic from sticking and will help to harden the surface of the joint filler.

New York Practice

Brooklyn, N. Y., uses a mixture of coal tar pitch, 100 parts; refined residual asphalt, 20 parts; to which, after thorough mixing, is added not to exceed one part of sand to one part of this bituminous mixture. The sand is fine, passing a 20-mesh sieve, and is stirred in usually by a mechanical mixer.

In the Borough of Manhattan one part of hot asphalt cement is mixed with not to exceed one part of sand, the latter to pass a 10-mesh sieve. The mixture is made in a concrete carrier or pushcart of about 7 cu. ft. capacity. The mixing is done with a rake or a perforated hoe. Both here and in Brooklyn the hot bituminous mixture is dumped directly upon the pavement and is pushed into the joints by means of hoes or squeegees. These forms of bituminous fillers give the best results for this class of filler. Bituminous fillers are most suitable for use when the traffic conditions are such that it is not practical to block off the street a sufficient time to permit the proper setting of a cement grout filler.

Cushion Course

The cushion course on top of the concrete is usually sand and it should not be greater in depth than an average of 1 in. This is sufficient with a specification allowing only a maximum variation of ½ in. in the depth of the blocks. Of course, the surface of the concrete should be smooth and it should conform to the crown of the finished pavement.

In some localities a dry mortar cushion of one part cement to four parts of sand has been used with success, especially where the joint filler was cement grout. This makes a very rigid pavement, and where the traffic warrants the additional expenditure of about 15 cts per square yard it is probably advisable. The mortar cushion has been used also with a bituminous filler, but this seems to the writer to be a useless expense, as the traffic is allowed on the pavement before the cushion can obtain a proper set, and an examination of many openings has failed to show him a case of a bond between the bottom of the block and the mortar cushion. The claim is made that this cushion does not wash if any water finds its way through the joints of the pavement. If the joint filler is properly placed in the joints there should be no trouble from this source, even with a sand cushion. With a cement grout filler the blocks are held rigidly and the cushion obtains a proper set as the traffic is blocked off in order to permit the grout to set, and the cushion has the same opportunity.

Recent Improvements in This Type of Pavement

Even with the great strides which have been made in granite block pavements in the past half a dozen years, there are still a great many people in our cities who picture the old style rough, open-jointed granite pavements when they hear granite mentioned in connection with pavements. As a matter of fact these same people will ride over the modern smooth surface granite block pavements laid with cement grouted joints or with the latest form of bituminous joints and not recognize that it is a granite block pavement and consequently fail to give it the credit which is its due.

The modern granite blocks, when properly laid, make a pavement which is as near permanent as it is possible to lay, and which is smooth and yet not slippery. While it is not wholly noiseless under metal tire traffic, yet because of its smoothness and the fact that the percentage of this kind of traffic is getting smaller and smaller each year, it is rapidly becoming a noiseless pavement.

The great improvement in the surface and the joints of this pavement in recent years has been due wholly to the cooperation between the engineers and the granite quarrymen. They have worked together in the endeavor to produce as good a block as it is practicable to make on a commercial scale, and then having these blocks paved better and closer than formerly and then really filling the joints with more permanent kinds of joint fillers. Neither the engineers nor the quarrymen could have accomplished this alone, but both working together with the same goal in mind resulted in great improvements in granite block pavements in a comparatively short time.

Acknowledgment

The foregoing discussion is from a paper by Mr. Pollock before Section D, Engineering, of the American Association for the Advancement of Science.

WATER WORKS DESIGN AND CONSTRUCTION

Breadth of View in Water Works Design

By John W. Alvord, C. E., Hydraulic and Sanitary Engineer, Chicago, Ill.

A good story is told about a medieval walled town which was undergoing a long and severe siege in which, the military men being largely killed off, the citizens were finally called together for a council of war. Many suggestions were made for driving off the enemy. Finally the town shoemaker arose and solemnly suggested that it was his judgment that a large number of extra heavy iron-tipped brogans should be made immediately and a given number of citizens so equipped go out and kick the enemy to death.

Breadth of View Comes from Familiarity with Many Plants

In water works design it is often true not only of the layman, but also the engineer, that his projects bear the stamp of a limited breadth of view. Engineers familiar with only one type of water works often drag in their "brogans" to every situation, regardless of applicability. Engineers who have grown up with a single large water supply sometimes find themselves curiously helpless when they are confronted with small-town plant design, and, conversely, those who have only built small plants often find it difficult to think in large unit quantities when occasion unexpectedly arises. Again, men who are skilled in load factors and stresses only oftentimes fail to grasp economic problems, and finally the all too

general suspicion of the laymen administrators who employ the engineer is that he does not always exercise business judgment in addition to his technical information.

The remedy for all this is obviously breadth of view.

Breadth Comes with Occupational Maturity

Breadth of view is acquired by experience, by constant and persistent study, by travel, with engineering information as a prime objective, but most of all it is acquired by what may be called occupational maturity, not necessarily the maturity of white hairs, but the maturity of long continued and concentrated attention centering around a given subject, but not limited to it alone.

It is one of the misfortunes of youthful designers that capitalists, and in fact almost all administrative bodies with any deep sense of their responsibilities, want as much experience and maturity as they can get for the money they can appropriate for engineering service. The underlying reason for this is sound, though not always pleasant to endure. Men with money to spend want to know that it is expended wisely; and they have an instinctive feeling that a certain kind of maturity is at least one of the requisites of wise expenditure.

Value of Experience on Small Works

It has been said that a large proportion of our great bankers are educated in the small towns, where the opportunities have been afforded them to become personally familiar with every phase of the banking business. Likewise the young water works engineer can usually accumulate a broad, valuable information more rapidly on engineering problems relating to a considerable number of small plants, for the engineering and economic problems of such plants are quite as exacting and often require more ingenuity and good judgment than problems on large works. In a given length of time the practitioner on a series of small plants will usually be engaged upon a greater variety of undertakings, and will become familiar with a large number of conditions, equipment and devices, than will engineers who have been devoting themselves to a single large task.

Acquaintance with All Available Devices Is Requisite

There is scarcely a water works device upon the market or a form of general design that is not most applicable to some particular set of circumstances in the water works field. No technical or mathematical ability can take the place of an intimate acquaintance with all the available devices capable of accomplishing a certain purpose, and the characteristics of equipment that make it applicable or economical in one situation and less desirable in another.

This ability to surround his subject, to get everything into the proper perspective, and to look at it from all points of view, is a quality notably lacking in the layman, the so-called practical water works man, and even many engineers of only limited experience.

Complete Study of Water System Necessary

The engineer must have an analytical type of mind in order to acquire this proper perspective. He should not permit the real problem and its proper solution to be hidden by improper limits placed upon his investigation by clients who are often groping in the dark. In ordinary practice the engineer is frequently employed to plan a specific remedy, such, for instance, as drawing specifications for new pumping equipment, an addition which, perhaps, in the guess of some alderman, should insure a plentiful water supply. The experienced engineer often finds it necessary, after beginning his work and gaining some insight into the problem, to have his assignment radically changed, resulting, perhaps, in measures and remedies quite different from what was at first taken for granted as necessary. Procedure like this is the rule rather than the exception.

It is usually found that what is really needed is a complete study of the water system. Only by such general study of a water works plant, periodically made, can expenditures be wisely governed, so that each improvement is a part of the well-designed and balanced growing property, and investments thus made be not superseded in the future.

Fundamental Municipal Conditions Vital Factors

In the broader aspect of the design of water works structures, fundamental municipal conditions are often vital factors, and a close scrutiny of the past service and its deficiencies is necessary to determine the direction in which territorial expansion may take, the industrial prospects, local peculiarities, habits and the increasing needs of a growing population. These and other like matters are always interesting and important questions.

Designer Needs Prophetic Vision

It is almost always necessary for the designing engineer to become, in a sense, a sort of prophet, for he must design for the future, not for the past, or even the present, exclusively, and, therefore, the probable future conditions must be determined as accurately as is possible if the design shall fit the growing needs. This requires an intimate water works experience with a wide variety of conditions, and the judgment in these matters is greatly aided by a review of the past growth, not only of the plant in hand, but of many other similar plants. The gift of second sight is not required of the engineer, but this does not excuse him from determining as well as he can the most probable coming occurrences that affect his design.

Provision for the future does not necessarily involve present expenditures only useful a long time hereafter; on the contrary, it is one of the fundamentals of sound design that the immediate future shall not be overburdened with cost to provide for possibilities which may never develop precisely as expected, or which can be better financed when the needs are more fully disclosed. If the designer has correctly read the most probable future necessities, it usually happens that the design can be made capable of progressive expansion, so that it will permit the ready care of future requirements when they are fully apparent, without curtailing or destroying the value of past investments. This, again, can be accomplished only when ripe experience has been brought to bear on the problem.

Design Reflects Maturity of Designer

Every completed and operating water works plant writes the story of its designer's mind, experience and maturity, but it is a story that cannot be read by the uninitiated. The experienced water works designer visiting a plant for the first time reads with a keen interest the study of its original designer, and observes where he looked into the future and looked correctly. The intelligent observer of a record of this kind will not be filled with cheap or carping criticism, for he knows too well that foresight is more difficult than hindsight, but he will be pleased when he discovers that his predecessor was intelligent, thoughtful, experienced, and prophesied clearly and correctly, for that is nothing short of breadth of view.

How important breadth of view can be in emergencies is well seen in the recent cantonment construction for the U. S. Government. The supervising engineers locally employed at each cantonment each received a typewritten copy of general instructions from Washington, framed up by water works engineers of ripe experience and outlining the general intent and policy of the works to be constructed. So complete and well thought out were these instructions that no question remained to be asked, and modification to suit local conditions in each case was all that was necessary. Only those who entered the desperate race against time, which the building of these temporary cities involved, could realize how large was the saving of time and the avoidance of delay by this wisely matured forethought.

Rivers as Sources of Water Supply

By Robert Spurr Weston, of Weston & Sampson, Consulting Engineers, 14 Beacon Street, Boston, Mass.

Three main sources of water supply are in general use—namely, wells, lakes and rivers—and of these rivers are of chief importance in the United States, where, as a rule, abundant ground water supplies are not located near large centers of population, and although many cities, like on the Great Lakes and in the northern tier of states, draw abundant supplies from lakes, the vast majority must turn to the many large rivers, usually abundant in the most populous parts of the country.

It is universally agreed among sanitary engineers that most river waters—excepting perhaps mountain brooks and the like—are unsafe for drinking purposes unless purified either by long storage, filtration or sterilization.

Purification by Long Storage

Purification by long storage was the first method employed. The employment of this means of purification was largely adventitious because storage for quality was only an attendant circumstance of storage for quantity. As early as 1890 it was generally recognized by sanitarians that cities which used stored water from sparsely populated drainage areas, or which drew their supplies from deep wells, suffered less deaths from typhoid fever than cities taking water directly from rivers, or indeed from lakes at points which were occasionally contaminated with the city's own sewage.

Among the best supplies were the impounded Croton, Sudbury, Saugus, Hobbs Brook and Passaic Rivers, supplying the cities of New York, Boston, Lynn, Cambridge and Patterson. Among the worst were those supplying the cities of Birmingham, Denver, Allegheny, Camden, Pittsburgh, Lawrence, Newark and Lowell, with sewage polluted water pumped directly from rivers. Many of these impounded supplies, with improvements and additions, are still as safe and of as good quality as any, and the typhoid fever death rates in New York and Boston are among the lowest in the United States.

Reduction of Typhoid Due to Purification and General Sanitation

It has not always been possible or economical to secure an impounded supply of sufficient volume and many cities have been obliged to use water from rivers. Before 1890 most of these waters were used without long storage or purification. Recently most cities have adopted some method of purification involving filtration, or have at least sterilized the water with chlorine. The use of these purified waters has been attended with great success and typhoid fever in such cities as Pittsburgh, Cincinnati, Philadelphia, Albany and Lawrence, has been reduced to below what sanitarians, writing as late as 1905, predicted would be the minimum when the water supply had been purified to the practicable limit. To use the technical phrase, purification and general sanitation have reduced the typhoid fever death rate far below the "residual typhoid limit," and as a result the typhoid fever death rate in many American cities is as low as that in some European cities noted for their low rates. Some of the striking reductions are given in Table I.

Therefore it has been proved statistically that river waters may be so well purified that the protection afforded the drinker will be as good as that afforded by the use of pure ground water, an impounded upland water or a pure natural lake water.

Rivers Must be Used

It is obvious that problems of water supply are problems of concentration of population and that hand in hand with the problem of water supply is joined the problem of pollution. Water borne infection is nothing more nor less than transferring disease producing bacteria from the anal end of one intestine to the oral end of another. By inspection or control of the river drainage area, it is not practicable to prevent entirely this transfer. Furthermore, rivers attract population, and population demands disposal of sewage as well as water supply. On some industrial rivers, the prohibition of pollution would so hamper industry that manufacturers would be forced either to go out of business or move away. Consequently many rivers must necessarily be used for manufacturing, drainage and municipal water supply. Others may become unfit for water supply and be relegated to drainage and manufacturing uses only. Each stream, in other words, must be used for the best interests of all riparian owners and with due regard to the rights and convenience of all.

Table I—Reduction in Typhoid Fever Death Rates in American Cities Following the Purification of their Public Water Supplies

City	Average Typhoid Fever Death Rate Before Filtration	After Filtration	Percentage Reduction
Albany, N. Y.	109	28	74
Cincinnati, O.	56	11	80
Columbus, O.	83	17	78
Lawrence, Mass.	110	23	79
Patterson, N. J.	29	9	69
Philadelphia, Pa.	63	20	68
Pittsburgh, Pa.	132	19	85
Scranton, Pa.	25	10	60

Impracticable to Use Some Rivers

In highly polluted and contaminated streams, dilution alone cannot be relied upon to make the water fit even for purification, and in these cases sewage has to be purified before discharge. Some streams are so small and so highly polluted that it is impracticable to use them for water supply. Such streams are the lower Blackstone and the lower Passaic. Even the water of the lower Merrimac, now used for the supply of the city of Lawrence, is difficult to purify on account of pollution with sewage and manufacturing waste.

Self-Purification of the Mississippi River

The great Mississippi River, however, serves as a source of water supply for cities, and serves as a drainage channel for all or part of 31 States. It is polluted and then repurifies itself naturally, or the sewage discharged into it is purified artifically, and the river below is used with impunity after repurification by artificial methods. Notwithstanding this extensive use of the river for all purposes, the dilution is large and the opportunity afforded for self-purification adequate. Consequently the river at New Orleans, while burdened with the mud of a dozen States, is only slightly polluted with disease carrying bacteria. Many kinds of water make up the Mississippi. There is the clear water from the lakes of Minnesota, Wisconsin and the North; the slightly turbid water of the Allegheny; the hard water of the Monongahela; that of the moderately turbid and moderately hard Ohio; the colored and slightly turbid water of the upper Mississippi; the muddy water of the Missouri; the hard, alkaline, turbid Arkansas water; the peaty, highly colored Yazoo water, and that of the Red river, with its burden of ochre colored suspended matter, all joining above New Orleans to make the turbid, moderately hard flood which rushes to the sea.

It is obvious that efficient sewage disposal is necessary in the upper branches of this river system, but farther down, where the dilution is greater, the methods need not be so refined, while in the main river its dilution alone is more

than ample to prepare the diluted water for treatment by ordinary water purification methods, and the removal of the mud by coagulation necessarily produces a hygienically safe water.

Characteristics of the Thames River

Entirely different from the lower Mississippi is the English river Thames. Probably no river has been studied more thoroughly. Prominent among those who have investigated it are Wanklyn and Frankland, Dibdln, Rideal, and, more recently, Dr. A. C. Houston, Director of Water Examination of the Metropolitan (London) Water Board.

The Thames is a small stream, carrying slightly turbid, moderately colored and slightly polluted water. It lies entirely in England; it has a drainage area of 6,000 square miles and a length of only 210 miles. At its source it is 370 feet above sea level and flows into the North Sea with an average slope of 1.75 ft. per mile. With this slope, average velocities of as low as 0.25 mile per hour occur in September, and as high as 4.5 miles per hour in February. It is evident, therefore, that conditions favorable for self-purification exist in this stream, and notwithstanding the fact that it drains a populous country, contributing raw and imperfectly purified sewage to the stream, London has enjoyed a typhoid fever death rate far below that of any American city, and, in fact, below that of most European cities, notwithstanding the low efficiency of the filters, especially in former years. As 60 per cent. of the supply comes from the Thames and 20 per cent. more from the River Lea, it is obvious that London consumers are supplied with a hygienically safe water. So great are the factors of dilution, sedimentation and the antagonism of other organisms that disease bacteria do not survive very long or reach the intakes of the various works reduced in vitality. Houston has stated that there was little to choose in favor of an intake 55 miles above Hampton as compared with the existing one at Hampton.

Purification of Thames Water

The Thames water is purified by storage, followed by filtration through slow filters. Storage alone for about 15 days in the Chelsea reservoirs removed 95.3 per cent. of the bacteria growing on gelatine, and practically 99 per cent. of the B. coli. Similar, though not so great, reductions were obtained in other reservoirs. Not only does storage remove disease bacteria, it also devitalizes them. Storage has also other practical and well-known advantages, such as flexibility of supply, decoloration and clarification of water, and it prolongs the period between filter cleanings. The filtration of the stored water still further purifies the supply, and in London the total bacteria are reduced in the filtered water to less than 1 per cent. of those in the raw water, while the filtered water contains less than one-thousandth of the B. coli present in the Thames water at the intake.

Sterilization

Another purification method is sterilization. This has been largely developed during the last five years. Two reagents are of practical use, namely, lime and chlorine. It was discovered that the lime used to soften water effected a marked reduction in bacteria. Houston has shown that this is due to an excess of caustic lime in the water, and he has applied the principle in practice, notably at Aberdeen, where a soft water was treated successfully with only 10 parts of CaO per million at a cost of less than 20 cts. per 1,000 U. S. gals., and at Sunbury, where the Thames water was disinfected with about 200 parts of lime (CaO) per million. In the latter case treatment, followed by slightly more than a day's storage in tanks, removed 76 per cent. of the color and 99 per cent. of the bacteria. Similarly striking results of this "excess lime" treatment have been observed at New Orleans, Columbus and other American softening plants.

Sterilization by Chlorine

Sterilization by chlorine is now too well established a practice for comment. The dramatic demonstrations of its efficiency at Bubbly Creek and Jersey City, by G. A. Johnson, have been followed by careful study and experiment and the use of the convenient liquid chlorine in place of bleach. At present the method may be depended upon to make safe any clear, low-colored water. However, it is not a substitute for filtration or storage in most cases, but a supplement thereto.

It is now generally admitted that river waters may be purified to any necessary degree. In some cases the simple removal of suspended matter by coagulation and rapid filtration, or a month's storage, is all that is necessary; in other cases the softening process, and again others the applicaton of a minute dose of chlorine guarantees safety. Even quite highly polluted streams may be made safe if the discharge of unpurified sewage be minimized.

Rivers Economical Supply Source in War Time

With the methods—storage, chemical treatment, filtration and disinfection—so well developed, and with sewage disposal to make the raw water clean, there are but few rivers in existence which cannot be made safe for domestic and dietetic purposes, although there are many streams which might be objectionable for aesthetic and psychological reasons. Therefore, when considering water supply problems, especially in war time, when the strictest economy is imperative, the apparent superiority in quality of the usually expensive distant lake or impounded source should be scrutinized with careful comparison with the usually cheaper and equally safe river supply from near at hand. Again, although the number of unsafe supplies is rapidly decreasing, many cities have abundant supplies of unsafe river water. In many of these cities, the old supply is abandoned when by purification it could be utilized with safety and satisfaction for years to come.

Conclusion

In conclusion, the writer will state that most river waters may be used as sources of water supply with dependable safety if purified by modern methods; and there is, in most cases, little reason to choose more expensive supplies from other sources for fear that the river supplies cannot be made agreeable and perfectly safe.

REFUSE COLLECTION AND DISPOSAL

Operation of High Temperature Incinerator Plant at Savannah for Three Years and Nine Months

By E. R. Conant, Chief Engineer, City of Savannah, Ga.

(The Destructor plant at Savannah is one of the very few in the country that gives such high credit for by-product steam. Since the commencement of the operation of this plant, no objection whatever has ever risen from the people. It has been operated in such a manner that there has been no obnoxious odor or unsanitary conditions from which a complaint could emanate.—Editor.)

The December, 1914, number of MUNICIPAL ENGINEERING

contained a description of the high temperature refuse destructor at Savannah, which was completed and put in operation on April 1st, 1914. It has been in continuous operation since then, and so many inquiries are received concerning the operation of the plant, that the writer thought it might be interesting to those interested in refuse disposal to learn what success Savannah has experienced with its plant, of which there are only a limited number in the United States. This is a high temperature destructor of the Heenan-Froud type and was constructed by the Destructor Company of 11 Broadway, New York City. It was completed in March, 1914, and only accepted after necessary tests were made to make sure that all guarantees made by the company were fulfilled.

Brief Description of Plant

The plant has a rated daily capacity of 130 tons of mixed refuse. This refuse consists of household, hotel, and restaurant garbage and rubbish collected from households, stores, and a certain portion of ashes from households, but not from manufacturing plants. Street sweepings and carcasses of dead animals are not destroyed, but are sold for revenue. The plant is of two units, with four cells to each unit. The refuse is dumped into a large hopper at the ground level, raised with Haywood buckets and carried to containers over the furnace by an electrically operated crane. The plant is only semi-mechanically operated. The clinker is withdrawn with hydraulic rams and the doors over the furnace are opened and closed likewise. No fuel is used other than refuse in consuming the refuse. There are two boilers, each unit of 330 horse-power. Steam is generated by the heat coming from the hot air and gases carried from the furnaces. The steam generated in the boilers is carried to the electric generator, which furnishes the power for the electrically operated equipment of the plant and any excess steam is conveyed direct to the boiler header in the water works pumping station, located about 100 ft. from the Destructor plant.

Amount of Refuse

Reference is invited to MUNICIPAL ENGINEERING of December, 1914, for a more complete description of the plant. The plant has been in continuous operation from April, 1914, to this date, a period of three years and nine months. During this period the total consumption of refuse was 98,717 tons, equivalent to 72.6 tons per day.

Under normal conditions the refuse is approximately of the following character and proportion: 40 per cent, in weight, which might be classed as garbage; 45 per cent rubbish; 5 per cent sweepings from stables; and 10 per cent ashes. However, during two months of each year, July and August, we have an unusual condition existing, in that there is a daily collection of from 15 to 20 tons of almost pure watermelon and cantaloupe rinds, or waste melon. The average daily consumption for these two months of each year, is 100 tons per day. In order that this additional percentage of garbage, which is very wet, can be consumed, it is customary to add from 10 to 12 tons daily of manufacturing cinders or ashes, which has been collected during the winter in piles outside of the Destructor Plant. This has been practically the only fuel required in order to destroy this extremely wet garbage.

VIEWS OF REFUSE DESTRUCTOR, SAVANNAH, GA., IN SUCCESSFUL OPERATION FOR NEARLY FOUR YEARS.

Left to Right—Exterior View of Destructor and Water Works Pumping Station—Turbo—Generating Set for Supplying Current to Cranes—Front View of Furnace Showing Power Method of Withdrawing Clinker—Feeding Platform—Receiving Floor —Main Water Pumping Station Utilizing Steam Produced by Destructor.

Experiments With Soft Coal and Wood Fuel

In 1917, in order to increase the amount of steam, it was deemed advisable to experiment with burning a small amount of soft coal and wood, and the expenditure for the two months of this year in which this experiment was made amounted to perhaps $300, which resulted in a greater saving of fuel at the Destructor Plant and its use was fully warranted.

Deducting the amount of refuse destroyed during these two abnormal months, the average daily consumption for the remainder of the period of three years and nine months, was 66 tons, which is really the quantity that produces the excess steam, which will be referred to later.

War Reduces Refuse Production

The household saving for the year 1917 is shown by the reduced amount of refuse collected during this year over preceding years. As every pound of refuse taken to the Destructor Plant is carefully weighed, we have accurate record of the saving brought about due to the war situation. To

compare the saving it is proper to deduct refuse collected during July and August, for if anything during the watermelon season this year, there was a greater consumption of this cheap article of food over the preceding years.

Taking ten months of this year and comparing same with ten months of 1915 and 1916, it is noted that the daily collection for this period for 1917 was 60 tons, 1916 was 66 tons, 1915 71 tons, 1914 for seven months 73 tons.

Expenditure Made in Destroying Refuse for Three Years and Nine Months

Operation:		
Labor	$61,506.00	
Material	6,101.00	
Total		$67,517.00
Maintenance:		
Labor	$ 1,200.00	
Material and repairs, including labor and material	7,967.00	
		$ 9,167.00
Outlays	$ 2,596.00	
Clinker disposal	5,091.00	
Weighing of refuse	3,199.00	
Handling cinders for fuel during July and August, each year	1,900.00	
Fuel purchased	500.00	$13,286.00
Grand Total		$89,970.00

Credits on Operation

Amount of coal used as fuel at Pumping Station is carefully weighed daily. The value of steam turned over the Waterworks, is determined by deducting the amount of fuel actually used from the amount that would be required for pumping water, if there was no auxiliary aid furnished. It has been determined that the saving in fuel for the nine months of 1914 was $5,933, for the year 1915, $6,562; for the year 1916, $5,529, and for the year 1917, $7,500, making a total saving of fuel for the three years and nine months $25,524. The increased saving in 1917 is due to the high cost of coal.

The amount of clinker removed during the three years and nine months is approximately 25,000 tons. The cost of removing clinker was 20 cents per ton. A certain amount of this clinker was sold and a certain amount used for filling holes in suburban roadways or for hardening roadways. The credit value for this was $3,000. The remainder of this clinker was used in filling in land, which greatly enhanced its value and a credit of $1,963 is glving for this filling, so that a credit for clinker should be considered equal to the cost of removing it.

Credit is also given to outlays enumerated in a total cos amounting to $2,596 and for material on hand at the end o year valued at $3,000.

Summary of Credit

Steam	$25,524.0
Clinker	4,963.0
Outlays	2,596.0
Material on hand	3,000.0
Total	$36,083.0

Deducting this from the total expenditure noted leaves a net cost of $53,887, or a net cost per ton of 54.6 cts. The guaranteed net cost of operation, assuming that the plant is worked to its capacity of 130 tons per day is 40.4 cts. per ton. As noted with the exception of July and August of each year, the consumption is only 66 tons per day. Any increase over 66 tons, would materially increase the amount of steam furnished the pumping station, for at 66 tons there must be enough steam to operate the Destructor Plant and anything over the amount required would be a saving, so that if the plant was operated at its full capacity the cost of destroying refuse would be below the guaranteed cost of 40.4 cts. per ton. During the months of July and August, when the garbage is so very wet, there is practically no steam turned over to the pumping station.

Plant Has Made Good.

The official tests at the time the plant was accepted showed that no odor of obnoxious gases escaped from the building that the temperature in combustion chambers exceeded the guarantee and that the steam generated exceeded that required. The three years and nine months period that it has been operated prove its success and show that the plant equals the performance guaranteed by the builder and expected by the purchaser.

The costs given do not include interest on investment nor depreciation. It must be recognized that destroying a city's refuse by incineration is an expensive method, but at the same time it is the most sanitary and hygienic method known. The character of the refuse in the Southern cites is different from that of the cities in colder climates. The garbage portion of the refuse is less here than in northern cities and the quality of that collected is insufficient to warrant the adoption of the reduction process. There is every indication that under existing war conditions the feeding of garbage to hogs is a feasible method of utilizing this portion of the city's refuse and consideration is being given in this city to separate collection of that portion of the garbage suitable for feeding to hogs to be collected and used in this manner.

SEWER DESIGN AND CONSTRUCTION

Some Practical Hints on the Design and Construction of Sanitary Vitrified Pipe Sewers

By Charles E. Collins, Consulting Civil and Hydraulic Engineer, Drexel Building, Philadelphia, Pa.

The present article is intended to cover only some of the more important parts of the design and construction of sanitary vitrified pipe sewers. In designing sanitary sewers probably the most important part is a careful study of all the conditions having a bearing on the sewers or system of sewers to be designed. To be able to make such a study the designing engineer should have an accurate survey of the area to be covered.

Accurate Survey

This survey should include accurate profiles of all of the streets, elevations of the ground at a sufficient number of points between the streets, so that a contour map may be prepared of the total area to be covered by the sewer system, the elevation and location of the lowest cellars or basements in each block, the location in plan and elevation of underground structures in the streets, the location of watercourses, street railway tracks, streets and alleys.

Where there is any doubt whether rock will be encountered or where it will be encountered and the depth below the surface of the street cannot be ascertained from the data at hand

borings should be taken at sufficient points to enable the engineer to make an approximate estimate of the amount of rock to be excavated from trenches.

As the number of persons within a certain area in different parts of the city will vary, memoranda should be made in the field notes showing density of population for different sections of the city, also manufacturing and business sections, the amount of water per capita per 24 hours at different seasons, whether meters are used, and if only part of the system is metered give percentage of metered connections to total connections, also relation to gallons used, the number of persons served and amounts used for manufacturing purposes, the present population and the increase in population each ten years for the total number of years covered by the records. The above covers briefly and in a general way the most important data that is included in the survey.

Map and Profiles

After this data has reached the office it is the writer's practice to have a general topographic map and profiles prepared of the entire area to be covered, an estimate made of the number of persons to be served and the amount of sewage and ground water that will be contributed by the various parts of the system. Referring to the field notes, we find the areas covered by the different degrees of density of population, from which we readily determine the population per unit of area, or unit of frontage, on the sewer line for all built-up sections.

Estimating Population to Be Served

The field notes also give the classification for different degrees of density of population under which undeveloped land should be placed, so that the future population may be determined fairly accurately from these areas, using the same population per unit of area or frontage as exists in the built-up section for the same classification. In doing this, however, approximate street locations must be assumed through vacant lands so as to determine into which sewers the assumed volume of sewage will flow. In determining the location of these proposed streets the writer has used the same distance between street centers as existed in like areas in the built-up section, and while the undeveloped land has not in many cases been divided as assumed, yet the amount of sewage contributed to the sewers as designed and constructed has agreed almost exactly with the amount assumed.

It must be remembered, however, that this assumed future population is for the area after it is fully built up, and therefore must not include areas too remote from the developed section. To estimate the future population of a city requires a careful study of each problem, giving due consideration to its location, conditions and past growth.

In estimating future population the writer uses a curve made up from the average increase in population of several larger cities, starting at a point where each had approximately the same population as the city under consideration. These cities should be selected from locations similar to the location of the city under consideration and the general conditions that have had the greatest bearing on the growth of these cities should also be similar to the conditions in the city for which the estimate of population is being made.

Amount of Sewage per Capita

Having arrived at an estimate of the future population, the next step is to estimate the amount of sewage per capita. Where possible gaugings should be taken of the flow of sewage from the section of the city to be sewered and the rate per capita based on these measurements, provided in the judgment of the engineer this measurement seems to be within reasonable limits. I believe a reasonable limit is between 65 and 100 gals. per 24 hours per capita connected with the sewers, which should include all house sewage, water used for flushing sewers and small manufacturing wastes, but should not include ground water nor waste from large manufacturing plants. If no reliable measurements can be taken of the amount of sewage, it must be based upon the amount of water used after allowing for the increase that will result from the use of a complete system of sanitary sewers. The writer has usually found that if the water consumption amounts to from 70 to 100 gals. per capita, 80 per cent. of this amount is a fair estimate of the amount that will reach the sewers. If the amount is less than 70 gals. per capita per 24 hours, it is best to assume that it will reach this amount later. If the amount of water used is in excess of 100 gals. per person per 24 hours, after deducting the amounts used by large manufacturing plants, I believe it is due to unnecessary leakage, of which at least 50 per cent. of the amount over 100 gals. is through defective joints in the mains and would not reach the sewers; therefore, if the records show that more than 100 gals. per capita per 24 hours is being used, at least 50 per cent. of the amount over 100 gals. should be deducted before taking 80 per cent. of the amount used as the amount that will reach the sewers.

Ground Water Infiltration

The amount of ground water will depend upon the length of sewers exposed to ground water, the head of ground water on the sewers, the kind of joints and workmanship in making them. There is a seasonal variation in the head of ground water in the sewers and of the length of sewers exposed to ground water in every system. In some systems practically the entire length will be under ground water at certain seasons and at other seasons there will be but very little or no ground water above the sewers. The specifications should be drawn so as clearly to specify the kind of joints to be used and the method used in making them. The workmanship in making joints will vary under different engineers and inspectors, so that there will be a wide variation in the amount of ground water entering the sewer under the same conditions, depending upon the engineer and inspector having the work under their direction, and while the experience of other engineers is valuable, I believe each designing engineer should base his estimate of the amount of ground water to be taken care of largely upon his personal experience.

Weir Measurements of Infiltration

The writer recently made careful weir measurements of the amount of infiltration of ground water into a system of sewers constructed under his supervision, consisting of about 27 miles of vitrified pipe sewers, varying in size from 6 to 36 in. in diameter, and in trenches varying in depth up to 32 ft., and in some instances the sewers were laid in wet ground and in fine running sand. The measurements were taken in the spring after heavy rains, following the construction of the system, and before connections were made with the houses. The flow of ground water from the sewers reached a maximum of 216,000 gals. per 24 hours, or about 8,000 gals. per 24 hours per mile of sewer. With American Portland cement joints, one of sand to one of cement, and first-class workmanship, the infiltration in vitrified pipe sewers should not exceed 10 per cent. of the estimated amount of sewage when the ground is at its maximum elevation. The necessity of employing only skilled and absolutely reliable workmen under rigid inspection on this part of the work should not be overlooked if the best results are to be accomplished. I believe the use of quick-setting cement in wet ground also reduces the amount of infiltration and under very bad conditions it is on the side of economy to use a first quality sewer pipe joint compound.

Maximum Hourly Flow

After the engineer has carefully estimated the amount of sewage per 24 hours per capita, including infiltration, he should determine upon the maximum hourly flow. Unless there is some unusual local condition having a direct bearing on the maximum hourly flow the writer uses one and one-half times the average flow and designs the sewers so that when

receiving the maximum hourly flow the sewers will not flow more than two-thirds full.

Location, Size and Grade

Having determined upon the maximum hourly flow, the next step is to determine on the locations, elevations, grades and sizes of the sewers. When practical it is preferable to locate the sewer in the center of the street and at such an elevation as will drain all basements. Minimum grades should, as far as possible, be limited to those that will produce a flow of 2 ft. per second. With the aid of the topographic map and profiles, on which should be indicated the elevations of the lowest cellars within each block and the elevations of the surface of the rock, the engineer should, after a careful study of all the conditions having a bearing on the design, be able readily to determine locations, sizes and depths below the surface of all lateral sewers, then the most economical location, size and grades of the intercepting sewers, finally bringing all into one main intercepting sewer terminating at the disposal plant.

Information on Maps and Profiles

The topographic map should be drawn to a convenient scale and should show the general plan of the system, on which should be marked in figures the elevations of the sewer at all manholes, flush-tanks and changes of grades; also the sizes and rates of grade of all sewers should be shown in figures. The profile sheets should show a plan and profile of each street drawn to a scale that will clearly show the depth of the sewer below the surface and on which should be marked in figures the elevation of the sewer at all manholes, flush-tanks and changes of grade; also on the profiles should be marked in figures the sizes and rate of grade of each sewer. The writer has found the most convenient size of these sheets for profiles to be about 10x18 in., which, after being blue-printed, are indexed and bound in book form. Detail drawings of manholes, flush-tanks and of any other special form of construction required should be drawn to a convenient scale and all dimensions clearly shown in figures.

Specifications

Specifications should be prepared so as to specify in a clear, definite wording just what is included in the specifications and contract, and each part should be definitely and clearly specified so that there can be no question as to the kind of material or workmanship required in any part of the work. All materials should be required to pass a certain test as specified, and as far as possible based upon standard methods and tests made by the American Society for Testing Materials, or some other recognized authority on tests for the materials specified, but this should be clearly stated in the specifications so that there can be no doubt as to the method of making these tests, also the strength, etc., required for acceptance. This should include sewer pipe as well as other materials. It must be remembered that unforeseen conditions may arise and the specifications should be prepared with this in mind, so that the contractor, when he prepares his bid, may know clearly and definitely how he is to be paid for all classes of work that he may be called upon to carry out in the full execution of his contract.

The Irresponsible Low Bidder

In connection with the construction I think a brief reference to the prices bid or to be paid for the work is not out of place. Contractors sometimes, through lack of knowledge, by mistake or with a feeling that they will construct the work "good enough" or "just as good," but by methods and materials much cheaper than those specified, underbid the engineer's estimate and also underbid experienced, reliable contractors, who carefully prepare their bids with as small a margin of profit as is consistent with good work.

When these low bids come before a city council or committee the lowest bid is often accepted, sometimes with the advice of the engineer, but often contrary to the advice of the engineer, with the result that the contractor becomes insolvent, the city becomes involved in an expensive lawsuit, with a final result that the total cost to the city is considerably more than the amount given in other bids that would have given the contractor a fair profit and the city good value for the money expended and the kind of work specified.

The contractor should receive a price that will return a fair profit after completing the work in entire conformity with the terms of the contract, plans and specifications and the city should not accept a bid that is clearly shown by their engineer and also by a careful analysis of all the bids submitted, the costs of labor and material being carefully considered, that the price bid is too low to return a fair profit. Every possible consideration, however, should be given to the low bidders, and when the lowest bid is not accepted a clear, definite statement should be made giving the reasons in detail why it was not accepted.

Inspection

Careful inspection should be made of all materials as they are received, and where doubt exists as to the quality of the material, it should be tested before any part of the material is used. Some materials may be tested at the factories, but sewer pipe should not receive a final test until it is unloaded from the freight cars at its point of destination, and again inspected as it is being laid. Infiltration of ground water adds to the cost of the sewers due to the increase in size, and where the sewage is pumped before it can be treated at the disposal plant there is a continuous expense of pumping and also the additional cost for larger pumps and equipment. There is also an additional expense connected with the construction and maintenance of the disposal plant due to the additional amount of water, therefore the materials used as well as the workmanship in making these joints should be carefully inspected, as it is a very important part of the work. By far a greater part of the ground water in sewers does not filter in through good Portland cement joints, but comes in through holes in the joints that could have been avoided without additional expense if the proper care had been exercised in making the joints.

Laying Pipe

In laying sewer pipe, particularly the large sizes, it is very important that the bottom of the trench be properly prepared to receive the pipe and that the back filling under and around the sides of the trench be properly and carefully carried out. If the bottom of the trench should be in fine running sand, or soft material that will not make a proper foundation, a foundation of lumber, gravel or concrete must be used. If the bottom of the trench should be in ledge, shale or hardpan it should be removed for a depth of 6 in. below the bottom of the pipe and refilled with sand, fine gravel or earth that will thoroughly compact, and after this material has been placed and thoroughly compacted it should be shaped the same as the bottom of earth trenches. In excavating the bottom of earth trenches for all sewers more than 15 in. in diameter, the part below the grade one-fifth of the diameter of the pipe above the grade line of the sewer, the excavation should be shaped to fit the outside diameter of the pipe by using a form with a steel edge or shoe shaped on an arc of a circle with a diameter a little less than the outside diameter of the pipe. This is used in finishing the bottom of the trench just ahead of the pipe-laying. By excavating the bottom of the trench to fit this form and to the exact grade, considerable time is saved because it is lowered into place. It also has the additional advantage that the pipe is firmly and evently bedded, and as the diameter of the arc of the form used is less than the outside of the pipe, the bearing on the top part of the concave surface will be very firm, making practically an unyielding cradle for the lower part of the pipe.

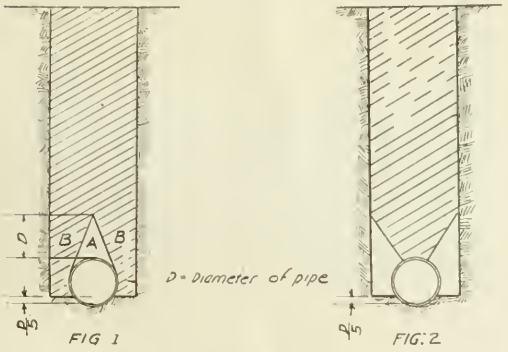
Bell holes should not be larger than is necessary and should be carefully back-filled and thoroughly tamped with special

tools for this purpose. It must not be overlooked that it is often necessary to use a concrete foundation and a concrete cradle to protect large size vitrified sewer pipe in trenches where the loads on the pipe would cause failure without this protection. Tests carried out and the results given by the Engineering Experiment Station, Iowa State College, and the American Society for Testing Materials are of great value to the engineer engaged in this kind of work, and these recommendations should be followed with the preparation of specifications, tests and laying vitrified sewer pipe.

Back-Filling and Tamping

The writer, however, has used the following method in back-filling and tamping around vitrified pipe sewers varying in size up to and including sewer pipe 36 in. in diameter. Materials that will thoroughly compact are selected for back-filling under and along the sides of the pipe, carefully placed and as thoroughly compacted as possible by hand-tamping.

As the back-filling reaches the grade of the center line of the pipe the tamping gradually approaches the center line from both sides, meeting at a distance above the pipe equal to the diameter of the pipe, as shown in Fig. 1. The area A above the pipe, while compacted from the tamping above, is not as firm as area B and I am of the opinion that as the load increases, due to the balance of the back-filling, there is an arching effect over the pipe, bringing a resultant pressure on



PRESSURE AREAS ON BACK-FILLED SEWERS.

the back-filling along the sides of the pipe and thereby relieving the pipe from a certain amount, but probably only a small amount, of the pressure that would otherwise rest on the center of the pipe if there was no settlement below a horizontal plane along the top of the pipe.

It also has its greatest favorable effect due to the fact that if these areas shown by B in Fig. 1 are not thoroughly compacted the earth begins to settle as the back-filling is completed and an arching effect takes place between the walls of the trench and the center of the pipe, bringing a resultant pressure on the center line of the pipe, as shown by the shaded section in Fig. 2, which is a much greater pressure along the center line of the pipe due to the settling in area B than would exist along this center line if there was no settling below a horizontal plane on the same grade as the top of the pipe. Once these conditions are thoroughly established around the pipe they will not materially change. Proof of this can be clearly shown in digging up old pipes that have been in the ground for years, where you will often find an unfilled space along the side of the pipe. The same is true at the sides of foundations and other underground structures.

The writer has found large size sewer pipe to fail under a back fill of 8 ft. above the top of the pipe where the back-filling along the sides of the pipe was not thoroughly tamped, while under his direction 30, 33 and 36-in. vitrified pipe sewers have been laid under back-filling as great as 30 ft. above the top of the pipe, and in 15 months after they were laid, through a very careful inspection found to be without cracks or any sign of failure. Thirty-inch sewer pipe that have failed have been replaced with vitrified pipe and the back-filling thoroughly tamped as above and in several months showed no sign of failure. I therefore believe that by far the larger percentage of the failures in the larger size vitrified sewer pipes could have been prevented by carefully and thoroughly compacting the back-filling under and around the sides of the pipe in the manner here suggested.

Sewers: When to Build and How to Pay

By Louis L. Tribus, of Tribus & Massa, Consulting Engineers, 86 Warren St., New York, N. Y.

When Cain was driven away from his boyhood home, because he failed in responsibility as his brother's keeper, it is a fair assumption that in the cities which he visited as a forlorn wanderer, few sewer systems were in existence. Some generations later, however, if excavated ruins tell the truth, the rich provided their extensive palaces and also some public buildings and market places with sewers; possibly for storm waters chiefly, but presumably as well for some human and household wastes; witness Rome and Crete.

Three Essential Phases of Sewerage Question

The sewerage question possesses three essential phases: (1) need; (2) suitable design and construction of sewers; and (3) paying the bills.

Need

As to the first; type of occupation, topography and soil all have bearing, but in general, it may be considered, when a community reaches the distinguished position of the possession of public water works, sewers must follow at once; else trouble develops.

Though dry disposal of excrement is practiced at times, notably at some of our army camps, water carriage is well-nigh universal because of its convenience. Scattered houses in country districts or even some favored villages, may be able to continue to use percolating cesspools, but usually the soil will not stand the strain long after modern plumbing is generally installed, for it becomes surcharged with liquid.

The unpleasant process of emptying cesspools becomes necessary, with an expense that soon cries for abatement so that sewers are demanded. Large estates may continue to operate individual disposal plants, but they do not as a rule seriously affect the average community's general needs.

Pressure From Board of Health

The first pressure usually comes from the Board of Health, which, for sanitary and somewhat from esthetic reasons, objects to overflowing cesspools, to polluted brooklets and to stagnant pools. Rightly so, for disease readily develops and spreads, not only lowering standards of health and perchance resulting in deaths, but also in other economic losses of time, wages and schooling; far more important features than most taxpayers realize. The influence of bad smells, also, may start a town thinking of sanitary precautions.

Granted that at times, portions of a village can get along with cesspools or other purely local disposal methods, while other districts can have no such facilities, the doctrine of mutual benefit comes straight to the front, and it must be said that very fair yielding to it is the general rule.

The earlier sewer problems are usually confined to meeting the "sanitary" needs, as the removal of domestic sewage is classed, but as desire grows for greater convenience, or perhaps it might better be said, less inconvenience, diverting storm flow also to underground channels becomes recog-

nized as a good policy. Here the benefit is obviously general rather than local, so that greater justice in taxing costs can be achieved, and spreading it over the drainage districts becomes the prevailing practice.

Much of interest could be said as to handling sewage in some Oriental lands, but special conditions there may not make the road center open channels so bad after all, for sun and scavenger dogs aid the bacteria effectively, though the sense of smell may be offended in the meantime. Smell is often thought to be unhealthful, but rarely does an odor cause harm; it is rather the red flag of danger.

The first object of sewers is to conserve health, the second, convenience, with, one might say, health affiliations.

Who are the beneficiaries? First, properties which can connect at once; second, those which ultimately may be reached by laterals, but do not need service at the time, and third, the incoming day workers from out of town, who find more healthful conditions attending their labor, and through rents pay their share.

Who Shall Pay?

Mutual responsibility having been recognized, need being apparent, sewers are ordered to be built. Who will pay? That becomes the big question, for one can fairly assume that the second factor, "design and construction" can be handled in a satisfactory manner, or at least with some regard to propriety and good engineering.

In a number of the states of this country the Department of Health controls the installation of sewers, i. e., as far as requirement and design goes, and quite properly demands the design of systems that shall provide for whole corporate areas, even though sewers may seem to be needed for only a part; and further, unless exceptional conditions prevail, suggestive plans for ultimate complete treatment works. No requirement for building the whole is enforced, but the plan must be comprehensive and parts first built be harmonious with the whole.

Treatment Works and Outfall Sewers of General Benefit

It is almost obvious that treatment works should be classed as a benefit to the whole community. If the works are large enough at first to care for the ultimate complete sewer system, the expense should be spread over the whole corporate area; if only sufficient for a portion of the sewer system, over its tributary area.

What applies to treatment works has equal force in regard to the larger outfall lines, which must be built large enough to care for the whole system when completed and in operation, if ultimate economy be considered.

Methods of Financing

Whether these design and construction costs should be covered by long or short term bond issues with sinking fund accompaniment, or by 5 or 10 or more serial payments, charged directly to the properties benefited, or by single direct assessments, depends very largely upon the sum of money involved and the financial abilities of the taxpayers.

As a matter of the greatest net economy, considering the financial interests of a full generation, the single payment system is the cheapest and the long run bond issue the most costly; yet there is some measure of apparent justice in spreading a cost that represents continued value, over a term of years, so that presumably a greater number of taxpayers will meet it, and the lesser annual payments be easier to meet.

It is almost universal custom to include maintenance and small repair costs in the annual tax budget and not an unfair policy at that, even if all properties have to pay a share; while some get no direct use of the sewers; for any sewers in service assuredly benefit to some degree the whole town. The principle of mutual responsibility and advantage is thus tacitly recognized.

Paying for Collecting Sewers

How to pay the bills for the collecting sewers themselves, outside of the costs of main trunks and disposal plant, heretofore discussed, brings, however, many a tough proposition to decide, and complaint universal.

The law guiding assessors, usually calls for a use of their judgment in assessing shares of costs according to the amount or benefit thought to be secured by each property. This necessarily takes into consideration the current use of properties. If carried out logically, three adjoining plots of equal land value, one unimproved worth $3,000, one, a $20,000 private residence occupied by a single family and the third improved with a $20,000 hotel for 100 guests, would pay very different proportions of sewer assessment, because of their varying use.

Payment for Actual Rather Than Possible Use.

Consider the possibility of a fire destroying the two buildings, shortly after the sewer assessments had been paid. Their owners decide to change from the previous use of the land; on the vacant lot is built a hotel with large need for sewerage, and on the hotel site rises a store with minimum plumbing equipment. The vacant lot owner paid but a small assessment, yet shortly makes the greatest use of the sewer, while the original hotel man paid the largest amount, yet secures but a slight final service. The underlying principle is fairly correct however, payment for actual, not simply possible use, for the differences indicated in the cases cited become fairly well adjusted in other ways and such violent changes as the one cited do not often occur.

Where rigid observance obtains, of the principle of actual use, assessors are very apt to throw upon the community at large, a proportion of cost representing the sewers within lines of street intersections, and also some of the expense, where corner lots have sewers at both fronts and sides.

Various Ways of Paying

Not infrequently the total cost is divided into bond issue for one-half the cost for say 30 years, and direct assessment on properties benefited for the balance in proportions as may seem equitable and not burdensome.

In the old City of New York (now Borough of Manhattan) sewers were chiefly of the combined type and rarely less than 12 ins. in diameter; the custom became well fixed, of assessing directly on frontage the estimated equivalent cost of 12-in. sewer and over the tributary watershed the excess expense where larger sizes were placed. The relation of the assessments to large property values, rendered this a fairly just measure, but in the more recent development of the outlying boroughs where much lower land values prevail, great temporary hardship often has ensued, though partially relieved by legislation permitting ten annual prorata payments with interest on deferred sums, when the total exceeds certain amounts.

Under New York Village laws, many sewers were at one time built, through annual district taxation, each year certain lines being constructed. This resulted in a gradual completion of systems, on a basis of practically annual payments; a good method when honestly carried out and recognizing again, community responsibility and benefit.

Ideal Financing

As a financial problem solely, the nearer one payment for each property meets the cost of sewer construction, the cheaper in the long run and the more nearly are the best interests of all concerned.

No one set of rules can be promulgated that will be just under all conditions; a place where the large majority of property owners are day-wage earners, may have to resort to long time scattered payments, because of the imprac-

ticability of keeping savings long enough to meet large single payments.

In a large city with high cost properties occupied by those of wealth or with accumulated capital, the single payment becomes suitable. But in all cases, sewers are needed but none likes to pay for them.

BRIDGES AND BUILDINGS

The Franklin Street Reinforced Concrete Bridge, Waterloo, Iowa

By E. K. Borchard, Engineer, 30 Broad St., New York.

There may be some isolated locations for bridges where beauty should be subordinated to utility, but these are few and never within any municipality or township. In concrete bridges, good appearance may be secured without any sacrifice of utility or low first cost; and this factor makes concrete the first choice for municipal bridges.

Previous to the last two decades there had been little attention devoted to designing and building a bridge that was in harmony with its surroundings and pleasing to the eye. Open trusses and plate girders were provided with no effort at ornamentation or good appearance.

VIEW OF THE FRANKLIN STREET REINFORCED CONCRETE BRIDGE, WATERLOO, IA.

Today in concrete bridges even of the very smallest size, some simple ornamentation is provided at practically no increase of cost—in addition to the naturally pleasing look of sturdiness and solidity inherent in concrete construction.

Concrete Arch Bridges

The arch has admittedly a more substantial look than any other type of bridge superstructure. The large mass of the concrete in an arch absorbs all vibrations from vehicular loads —at the same time the arch provides ample waterway or headroom.

The bridge shown in the illustration shows admirably the possibilities of concrete bridges for highways. This bridge is the Franklin Street Bridge at Waterloo, Iowa. The ornamentation is simple and dignified—yet only possible in concrete without excessive cost. This bridge shows only a moderate effort toward ornamentation; many bridges have been built of concrete in very ornate style.

Design Features

In the bridge shown the surface of spandrel walls are relieved by a sunk panel, while the arch ring is accentuated by a V-groove. At piers and abutments a very pleasing yet simple treatment is given by breaking what would otherwise be a broad expanse of concrete into ribs to give the effect of three narrow columns.

The balustrade guard rail deserves special notice for the neat balusters of concrete, surmounted by a concrete guard rail. Consider what the cost would be if these balusters and rails were all worked in stone. The guard rail pedestals over every pier and abutment support metal lighting standards, each provided with five electric light globes.

Advantages of Concrete

Good appearance is only one of the advantages of such a bridge as this. Low first cost, absence of maintenance costs, resistance to floods and permanence are additional reasons for building of concrete. With this bridge there will be no need for periodic renewal of bridge floor with consequent obstruction to traffic and no heavy expenses for repainting every few years.

New Club Building of The Engineers Club of Dayton

The new club building of The Engineers Club of Dayton, Ohio, is to be dedicated February 2, 1918. The structure, in perspective, is here illustrated. The membership of the club at this time is about 300.

The Building

The building is located at the southeast corner of Monument avenue and Jefferson street, facing the river, near the center of the city. The classical detail has been followed in the architectural design of the building, giving a refined dignity consistent with the high class character of the entire structure. It is three stories high, facing 150 ft. on Monument avenue and 125 ft. on Jefferson street.

The exterior is built of Bedford, Indiana, limestone and soft-toned gray buff brick laid in Flemish pattern with wide

PERSPECTIVE VIEW OF NEW CLUB HOUSE, ENGINEERS CLUB OF DAYTON.

white mortar joints. The design is a strong Georgian effect giving a dignity and refinement well adapted for an engineering building.

The main entrance fronts on Monument avenue although there is also an entrance on Jefferson street as well as porte cochere entrance on the east side. Passing through the main entrance one enters a simple vestibule which opens into a very attractive first floor lobby.

Directly south of the lobby entrance is a broad English stair leading to the second floor, treated in Caen stone effects,

with ornamented ceiling and frieze. To the right of entering are located the secretary's office and telephone booths, and beyond is a large billiard and game room which is provided with a large stone fireplace, English ceiling and wainscoting and cork floor.

To the left of the lobby is a broad visiting gallery at the east end of which is the porte cochere entrance. Entrances from the gallery also open to the sunken garden to the south and the ladies' reception room carried out in the Adam period of refined detail. A ladies' retiring or dressing room adjoins the reception room while check and toilet rooms are conveniently located.

South of the lobby and down marble steps is the dining room foyer with checking facilities and entrance to the sunken garden to the east and Jefferson street to the west.

Directly south of this foyer is the main dining room off which open eight private dining rooms, all of which may be thrown together with the main room making a large room for banquet purposes. South of the dining room is a white serving room and kitchen provided with the latest improved equipment for efficiently handling the service of the Club.

From the second floor lobby open a large loggia to the north, large lounging room to the west, library and conference rooms to the east and an auditorium foyer to the south.

The lounging room, located directly over the billiard room is 30 by 50 ft. with a large stone fire-place on the south side, high English wainscoting and heavy wood beamed ceilings, all kept in soft quiet coloring making a restful atmosphere.

Just east of the lobby is located a large library and reading room, off which open two library alcoves and two large conference rooms, in all of which bookcases are built to the ceiling accommodating over 10,000 volumes.

From the auditorium foyer one enters a large, spacious auditorium or lecture hall, accommodating about 450 persons, which is provided with a sloping floor, easy fixed seats, large stage and a thoroughly equipped fireproof lantern booth. This booth is entirely concealed at the rear of the auditorium and is provided with all modern appliances and conveniences. Four fireproof stairways lead from the auditorium to the ground level which, together with a fireproof building, offer the best possible protection to the occupants.

On the third floor are two bed rooms. A suburban locker room is also provided on this floor for the convenience of those members living some distance from the Club building. The whole building is provided with large steel casement windows affording ample light.

WATER PURIFICATION AND SEWAGE TREATMENT

The Electro-Chemical Sewage Treating Process as Operated at Decatur, Ill., in 1916

By W. S. Shields, Consulting Engineer, Hartford Bldg., Chicago, Ill.

For the past ten years the city of Decatur, Ill., has been confronted with the problem of securing an adequate means of sewage disposal. It is a manufacturing city with a present population of some 50,000 people, and is located on the Sangamon river, a stream having a watershed above Decatur of some 862 square miles and a recorded flow varying from 0 to 4,500 cu. ft. per second. The city gets its water supply, which is now inadequate during dry seasons, from this river, by means of a dam which impounds sufficient water to draw from during seasons in which the flow is insufficient. For this reason the river below the dam has no flow for long periods of time in dry seasons except that produced by the sewage from the city sewers.

Sewage Collection System

The sewer system is on the combined plan, with four main outlets into the river below the dam. These sewers are known as follows:

(a) The Broadway sewer, a brick sewer of 84 in. diameter, serving a district of some 1,370 acres, including the major portion of the business section, the gas works, the Wabash Railroad shops, the Staley Starch Works and a slaughtering and packing establishment. It carries an unusually strong sewage, including approximately 1,000,000 gal. of waste liquor from the Staley starch factory, which contains sulphurous acid and is heated to such a degree as to create offensive odors when mixed with city sewage, causing numerous complaints from residents along the line of the main sewer. This sewer enters the river just below the dam at an elevation of 581 ft. above sea level.

(b) The Union street sewer, 60 in. in diameter, serving a district of some 434 acres, with some business property and factories, but mostly residences. It has a daily dry weather flow of some 1,500,000 gal. of average city sewage. It enters the river near the Broadway outlet and at an elevation of 591 ft.

(c) The Oakland street sewer, 36 in. in diameter, serving a district of some 155 acres area, all of which is residence property. The flow of this sewer is some 10,000,000 gal. per day. It enters the river valley at an elevation of 610 ft., then drops to the river bottom and enters the river at an elevation of 584.09.

(d) The Seventh ward sewer, a 7-ft. sewer, serving a district of some 530 acres of urban property, parks and some unsubdivided property. Its dry weather flow has been given at 1,000,000 gal. per day and its outlet into the river is at an elevation of 583.90 ft.

The elevation of the crest of the dam is 593 ft., and the water below, at ordinary stages, is 588.3 ft., with a fall of some 2 ft. per mile down stream. The valley is some ¾ mile wide, with high banks or bluffs on each side; the bottom lands have an elevation of some 596 ft., with a flood height of 605 ft.

Imhoff Tanks and Sprinkling Filters Recommended in 1915

In 1915 Messrs. Langdon Pearse and Samuel A. Greely, consulting engineers of Chicago, after making experiments with Imhoff tanks and sprinkling filters, reported upon several schemes for collecting and treating the city sewage, and recommended a scheme involving an intercepting sewer, partly in tunnel, and a treating plant consisting of Imhoff tanks and sprinkling filters, located near the outlet of the Seventh ward sewer. The cost of the improvement recommended was estimated then at:

For 15 acres of land, right-of-way, etc	$ 4,500
For intercepting sewer and connection	244,335
For treating plant and accessories	484,840
Total for improvement	$733,675

Their estimated annual operating expenses, including depreciation and interest, was $43,722, or $20 per 1,000,000 gal. for a 6,000,000-gal. daily flow.

Their scheme did not include the treating of the starch waste, the plant not being in operation during the period when the experiments were made, but they recommended that this waste be treated separately by the company, should the plant again operate.

On account of the high cost, its inability to issue sufficient bonds, and the remaining problem of the starch waste, which again appeared, the city was loth to undertake the improvement recommended.

Electrolytic Lime Process Tried

In May, 1916, the Electrolytic Sanitation Company, of Chicago, became interested in the problem and made examinations of the starch waste, taken as it left the factory, and of the sewage containing this waste, at the outlet of the Broadway sewer, also of the city sewage proper without the starch waste, and being desirous of demonstrating to the city and public the ability of the electrolytic lime process successfully to treat sewage, requested of, and were granted by, the city officials the privilege to erect and operate a treating plant of 1,000,000 gal. daily capacity.

The Electrolytic Process

The electrolytic process, as many of the readers will understand, consists in adding sufficient lime to sewage or polluted water to neutralize the acids therein contained and leave a slight excess of lime, then to subject the sewage to an electrical current of low voltage by causing it to pass between iron plate electrodes, arranged in banks; the current, acting electro-chemically upon the sewage, electrolyzes it, forming nascent oxygen and hydrogen. The time of contact is but a few minutes, yet as it leaves the machine the suspended and colloidal matters are flocculated and quickly separated, leaving a bright and generally stable effluent. The amount of lime used varies with the acidity and other chemical conditions of the sewage.

A test of the starch works liquor indicated that 4.5 tons of lime per 1,000,000 gal. would be required to neutralize the acids therein, while the sewage at the mouth of the sewer, containing one part of this same waste and two parts sewage, required but 1.5 tons per 1,000,000 gal.

Agreement Between City and Company.

The essential conditions in the agreement made between the company and the city, prior to the erection of the plant, were that the company should install a test plant of 1,000,000 gal. daily capacity; that a continuous test of 45 days' run should be made, which should be considered an official test; that during this test the machines should be operated under the direction of the engineers of the company and that the tests should be made and the results determined by two chemists, one selected by the city and the other by the company, and their reports and analysis, if they agreed, should be considered as official, and if they did not agree, then a third chemist should be selected to determine the results, and that his report should be accepted by both parties.

Guarantees Made

The company made the following guarantees:

(a) That the final effluent from the sewage passed through our plant and after one hour's sedimentation will show a removal of not less than ninety per cent. (90%) of suspended matter and ninety-five per cent. (95%) of bacteria, and will not be offensive in odor or detrimental or injurious to animal or fish life, and shall be subject to any reasonable or enforceable objection on the part of the Rivers and Lakes Commission of the State of Illinois.

(b) That the sludge will be pressed and removed without creating a nuisance or disseminating offensive odors.

(c) That not more than one ton of lime (calcium oxide) and 200 kilowatt hours of electricity will be required for each million (1,000,000) gallons of city sewage treated.

(d) That the plant, when operated in accordance with our instructions, will cause no offensive odors or be a nuisance in any way. If the above guarantees or any of them are not fully complied with to your satisfaction, we agree to remove the plant, without expense to the city of Decatur of any kind whatsoever, except those expenses specifically mentioned herein for the city to furnish free.

VIEWS OF ELECTRO-CHEMICAL EXPERIMENTAL SEWAGE TREATMENT PLANT AT DECATUR, ILL.

Exterior View of Plant. Apparatus Housed. Settling Tank in Foreground—Intervior View of Plant Showing Switchboard and Electrical Treating Machine.

In return the city commissioners, not being in position legally to enter into a contract, agree that should the plant conform to the aforesaid guarantees and requirements, and each of them, then the Board of Commissioners agrees to do everything in its power to carry out the plans hereinafter mentioned. In the consideration of the proposal before the City Commission it was explained and understood that the term "city sewage" was to be understood as sewage without starch waste.

Design of Plant

For convenience of location and operation it was later decided to locate the plant to take the sewage from the Broadway sewer and a site was furnished which required the pumping of the sewage to be treated.

The plant consisted of a low frame building 18 ft. wide by 72 ft. long, with a room for lime mixing and feed tank over the central portion thereof. The sewage was drawn from the bottom of the main sewer into a pit, from which it was lifted by a 6-in. motor-driven centrifugal pump into an elevated feed tank, in which was placed a measuring weir and overflow pipe to control the amount to be treated. The presence of the starch waste in the sewage produced such an offensive and

sickening odor that special care had to be taken to provide air-tight partitions around this tank.

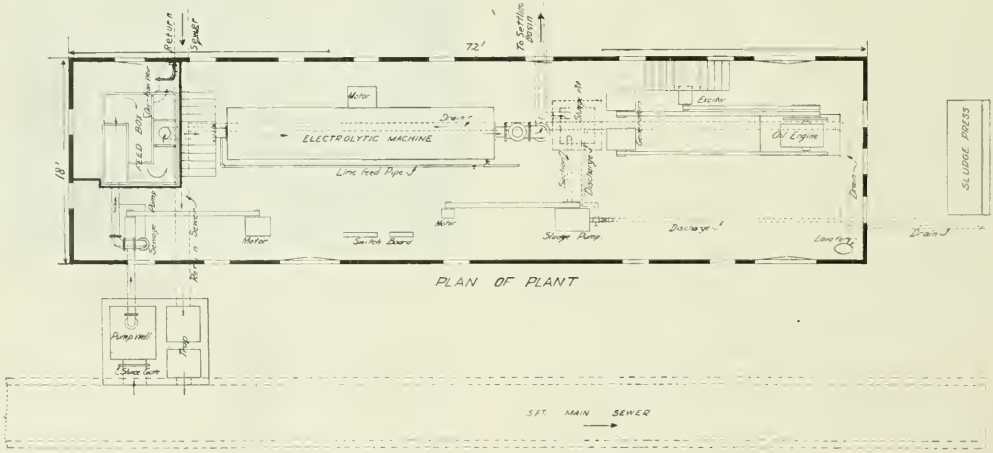
Screen Troubles

The Broadway sewer had a swift current and carried along its bottom an unusually large amount of grit and heavy matter, consisting of cinder from the railroad shops, coke washings from the gas works and flesh and hair from the slaughter house, and, owing to the method of connecting, practically all of this heavier matter flowing in the bottom current was drawn on to the screen, consequently the screen arrangement, while ordinarily sufficient for city sewage, was overtaxed and required much care and attention to keep it clear. The odors caused by the starch waste made this screening offensive to work with, and the screen caused more delays and stoppage of the machinery than all other sources combined.

The Treating Machine

The treating machine is a wooden box or closed flume, 23½ ft. long, with nearly square cross-section, 3 ft. on each side. It was mounted on a concrete base, was water-tight, with vents for releasing gases, and was provided with 10-in. circular openings in the center of the ends for the entrance and exit of the sewage.

The machine contains 22 banks of electrodes in two series of 11 each, consisting of 48 iron plates 3/16 in. thick and 10x16 in. The plates are ⅜ in. apart and between each plate there are two revolving paddles, driven by a 3-h.p. motor, to agitate and mix the sewage and to keep the surface of the plates clear of sludge and debris; in fact, the machine may be described as a huge electrolytic cell, and every part of the sewage passes between and is subject to the electrolytic action of a current of 40 volts and 70 amperes.



PLAN OF ELECTRO-CHEMICAL EXPERIMENTAL SEWAGE TREATMENT PLANT AT DECATUR, ILL., SHOWING ARRANGEMENT OF MACHINERY.

Settling Tank

From the machine the treated sewage passed to an open settling tank outside the building. This tank was constructed in excavation and lined with plank sheeting. It had dimensions 18 ft. wide by 60 ft. long by 10 ft. deep below flow line. The sewage entered the tank by falling over the side of a wooden trough extended across the inlet end, and in one end of this trough was an adjustable outlet weir to control the quantity of treated sewage to be passed through the tank. Baffle boards were provided and an outlet trough on the outlet end discharged through a weir chamber into a sewer which could carry the flow either back into the main sewer or into an open ditch, through which it could flow for several hundred feet and then enter the main sewer through a surface water opening.

Change from Flat to Hopper Bottoms

In adjusting and testing the plant prior to beginning the test it developed that, owing to the nature of the starch waste, the sludge which settled in the tank became septic rapidly and the flat-bottomed tank had to be changed to hopper bottoms, with a sludge pump and suction pipe, with a branch into the bottom of each hopper. The installation included a small sludge press of the Johnson type and a sludge pump and generator for producing current to operate the treating apparatus, and also a small oil engine. The latter was used more as an emergency machine than as a necessary part of the plant.

The Lime and Lime Equipment

The lime used was unslaked, lump lime, purchased on the local market and hauled a distance of approximately one mile, then elevated to the second story by hand, which made the operation both expensive and wasteful. The lime equipment consisted of a slaking tank and two solution tanks, in which were placed agitating apparatus driven by a motor. The lime mixture was pumped from the tank by a centrifugal pump to an elevated box, having an overflow so arranged that the excess mixture might return to the feed tank. The feed pipe extended from the box to connections at both ends of the treating machine, with valves so arranged that lime could be added at either end.

The inclusion of the starch waste not contemplated by the manufacturer when the equipment was shipped resulted in this lime-feeding equipment being inadequate for best operation, and as the electrolyzing of the free lime is an important function of the treatment, interruptions in line feeding necessarily affect the results and induce conditions which would not normally be present in a treating plant.

The Official Test

Construction work was started in the latter part of May and the plant put into operation early in July. As this was the first plant or complete installation on sewage work, and as the plant was to be temporary, there was, as in all first experimental plants, a number of changes and adjustments to be made, so that the official test was not started until the 31st day of July.

To conduct the official test the city selected as its chemist

TABLE I—CHEMICAL RESULTS OF ELECTRO-CHEMICAL SEWAGE TREATMENT AT DECATUR, ILL.

	Starch Waste Liquor (Raw)	Raw Sewage Union St. Sewer 2 Samples	Raw Sewage Broadway Sewer Without Starch Waste	No. 3 After Treatment	Percentage of Reduction	Raw Sewage from Broadway Sewer Including Starch Waste Av. 28 Samples (Composite Daily)	No. 5 Treated and with ½ Hour Sedimentation	Percentage of Reduction	No. 5 Treated and with 1 Hour Sedimentation	Percentage of Reduction
	1	2	3	4		5	6		7	
Total Solids	5866	1049	1184	839	....	1917	1585	....	1462	....
Soluble Solids	2133	703	964	803	....	1460	1494	....	1412	....
Suspended Solids	2733	346	220	36	83.6	457	91	80	45	90
Nitrogen as Free Ammonia	1.0	11.90	11.60	10.90	.60	20.01	9.50	52.5	11.3	43.5
Nitrites	.02	.025	.02	.12	....	.04	.20	....	.23	....
Nitrates	None	.265	.23	1.01	....	.56	.96	....	.94	....
Total Organic	590	22	28.10	20.60	27.0	79.2	69.80	11.8	62.0	21.7
Oxygen Consumed	1925	160	196	154	21.4	436.0	348	20.0	375	11.7
Lime (CaO) Required	1064	180	227	....	....	320.0	....	....	....	....
Lime pounds p. m. g.	8954	1501	1891	....	....	2671	....	....	....	....
Calcium Carbonate from Lime added	....	....	....	29	....	....	41	....	23	....
After deducting the calcium carbonate added by the treatment	....	....	....	....	96.8	....	....	89.0	....	95.2
Av. Current used k.w.h. per million gallons as treatment D. C. 40.5 volts 66.75 amperes							75.28			
For turning paddles							44.42			

Dr. O. F. Reynolds, of St. Louis, Mo., and Prof. A. A. Tyler, of the Milliken University, at Decatur, as bacteriologist, while the company was represented by Messrs. Mariner & Hoskins, of Chicago, through Dr. J. Warne Philips in charge. These gentlemen each submitted separate reports which agreed in all essential particulars.

The test ran through 28 consecutive days and was terminated at the request of the city, as results were considered sufficiently demonstrative. The chemical results are indicated upon Table I, herewith shown. The quantity, conclusions, character and constituent parts of the resultant sludge was agreed to by both chemists and reported in Table II, herewith. They differ, however, as to the value of this dry sludge.

TABLE II—ANALYSIS OF SLUDGE FROM SEWAGE CONTAINING STARCH, WASTE LIQUOR, DECATUR, ILL.

Pressed Cakes.

Moisture	59.70
Solids	40.30

	Dry Samples (per cent.)	
	Reynolds (1 sample)	Philips (4 samples)
Volatile Matter	52.76	51.67
Non-volatile Matter	47.24	48.33
Nitrogen	1.84	1.58
Calcium Oxide	18.20	13.63
Calcium Carbonate	33.93	33.93
Total Phosphoric Acid (P_2O_5)	4.40	4.50
Phosphoric Acid (Available)	3.60	3.78
Potash	.37	trace
Total Grease	5.94	7.37
Free Grease	1.51	1.14
Fatty Acid	4.43	6.16
Moisture	6.36	6.36
Tons per m. g.	4.5	4.77

Findings of Chemists

The chemists both agreed to the following:

(1) That the process when applied to the combined flow of all sewers, including the starch waste, will fulfill all conditions of the guarantees.

(2) That the effluent containing starch waste was not stable by the usual methylene blue test, but owing to the action of sulphurous acid, this test was not a fair one, as samples of the effluent when exposed to the air in open vessels did not become offensive, but improved in color and odor.

(3) That the effluent from treated city sewage without the starch waste would have a stability of 100.

(4) That existing odors were destroyed and none produced.

(5) That fresh sludge when pressed and piled in the open did not develop odors.

(6) That city sewage without the starch waste could be successfully treated with 1,500 lbs. of lime per 1,000,000 gal.

Summary of Dr. Tyler's Report

A summary of the report made by Dr. Tyler on his bacteriological tests showed the following:

Sixteen samples were examined and showed:

	Per cent.
Reduction on Agar	85.0-99
Average	95
Reduction on Gelatine	87.5-99.5
Average	95
Total Average Reduction	95
Gas Formers (4 samples) Reduction	99
Liquifiers Reduction, about	99
Stability of Effluent	99

He further reports that, bacterial action still goes on, but the gas formers and liquifiers are so well eliminated that the effluent would never become offensive, and also states in closing that "The process is especially efficient in the destruction of colon bacilli and other putrefying bacteria, thereby destroying the offensiveness of the sewage in a high degree."

A Five-Million-Gallon Plant

The data obtained by operating the experimental plant and the reports of the chemists, as to the requirements, indicated that a plant constructed to treat the combined gravity flow of the Broadway and Union Street sewers, including such other smaller areas which might be brought to it by gravity or low lifts, would require an installation, having a daily capacity of 5,000,000 gals., with provisions for extending to 7,000,000 gals. by the addition of two other machines. Such a plant was outlined and estimated to cost approximately $200,000, including land, rights-of-way and the necessary intersecting sewers to bring the sewage to the plant at such an elevation that pumping would not be required.

It further shows that the greater dilution by the addition of the flow from the Union Streeet sewer would reduce the lime requirements when the starch waste is included, to at least 1 ton per 1,000,000 gals.

Cost of Five-Million-Gallon Plant

The cost to operate a 5,000,000-gal. plant to treat sewage containing the starch waste might be taken as follows:

	Per Year	Per m.g.
Administration and Overhead Charges	$ 2,555.00	$ 1.40
Labor—Three engineers, three assistant engineers and three laborers	8,600.00	4.71
Lime—One ton per million gallons or 365×5= 1,824 tons @ $5.90 per ton	10,767.50	5.90

Power—For screens, treating machines, sludge pumps, presses, driers, elevators and conveyors, lime crushers, and agitators, lighting and losses in transmission, 1,000 k.w.h. per day or 1,000×365 @ 1¼c per k.w.h.....	4,562.50	2.50
Sludge Drying—2.0 tons of coal per day, or 730 tons of coal, @ $2.40.....	1,752.00	.96
Heating—150 tons of coal, @ $2.40.....	360.00	.20
Oil waste and general supplies.....	1,283.00	.70
Maintenance, repairs, etc.	5.110.00	2.80
Total to operate	$35.000.00	$19.17
Interest and depreciation (7½%).....	15.000.00	8.23
Total	$50,000.00	$27.40

Value of Sludge

The Chemist reported that the sludge when dried to a 6.36% moisture had a specific gravity of .768 or 48 lbs. per cubic foot, practically one-third of which would be calcium carbonate, the value of which is doubtful. The present market price of nitrogen is unusually high and would warrant at least the following values per parts indicated, and assuming four tons of dry sludge per 1,000,000 gals. of sewage treated, the following values might be expected:

	Per m. g.	Per day
Nitrogen 1.71 units ×4=6.84 @ $3.00*.....	$20.52	$102.60
Phosphoric Acid units 3.69×4=14.76 @ 10c.....	1.48	7.40
Total	$22.00	$110.00
Cost to pump, press, and dry and prepare @ $2.50×4=	10.00	50.00
Available for Income	$12.00	$60.00

*Present market price $5.75 per unit.

Sludge Utilization

The utilization of this sludge in a manner to reduce the cost of operation is the part of the problem not solved, but in quantity it would amount to some 7,500 tons or 11,500 cu. yds. per year. If used as a fertilizer base the most economical solution would probably involve an equipment for manufacture of a fertilizer adapted for local requirements, rather than to sell wholesale where two freight rates must be charged against it before it reaches the consumer.

With no Current on, Polerization of Plates Aids Lime Treatment

Objections were made to the process that nothing had been accomplished which could not have been secured by a treatment of the sewage with lime alone and that the electrical treatment produced little or no effect; and to substantiate this claim the plant was operated by the city for several days when lime was added to the sewage and it was passed through the machine without the electrical current. Analyses made of samples taken during this time showed results much superior to anything that has heretofore been secured by lime treatment.

As the test was made without the knowledge of the company, the actual conditions, which then obtained, were not known to the writer, but undoubtedly the results were influenced by the electrodes, the plates of which were polarized to a degree as to produce a beneficial effect. The period of sedimentation used to obtain the results were not stated nor the rate and time in which the sewage was passed through the machine was not given. This is important, as the length of time in which the lime-treated sewage remained in the tank, more or less filled with sludge treated by electricity, would have beneficial effects.

An examination of the plates of the electrodes, after the few days' run without current, indicated a decomposition of the alternate plates, amounting to considerable more than had occurred during the entire period prior to that time; this indicated that a considerable quantity of iron had been decomposed which would have beneficial effect. At the end of this run the settling tank indicated septic conditions and more odor had developed than at any other time during the operation of the plant.

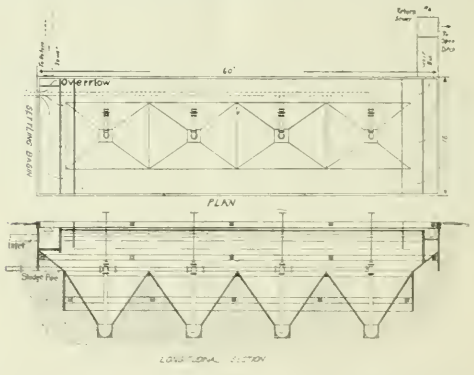
All Guarantees Fulfilled

The company were unjustly criticised for refusing to allow this test to continue as their machines were not built for lime process nor could they be used in this way without serious detriment.

At a heavy expense the Company had demonstrated that the process would successfully treat a combined sewage and trade waste of such a nature that no other process had been able to treat and at a cost to construct and operate quite within reason. According to the reports of the chemists employed, and their standing and ability cannot be questioned, all of the terms of the guarantees had been fulfilled and they are justly entitled to high credit for what they had done.

Some Cost Comparisons

Mr. Harrison P. Eddy in his paper read before the Western Society of Engineers in Chicago in October, 1916, in which he makes a comparison of the Activated Sludge Process with that of Imhoff Tank-Sprinkling Filter, makes comparative estimates on hypothetical plants of 5,500,000-gal. capacity. His summary of cost to construct and operate is here shown, together with that of an Electrolytic-Lime Process plant of



PLAN AND LONGITUDINAL SECTION OF SETTLING TANK OF DECATUR EXPERIMENTAL SEWAGE TREATMENT PLANT.

equal capacity, but to compare with the excess reserve capacity given by Mr. Eddy for the other plants the cost to furnish and install two additional units of 1,000,000 gals. capacity has been added to the cost for construction. The cost of operating the electrolytic plant has been reduced to conform with the cost of treating the average city sewage by a reduction in the quantity of lime to 1,500 lbs. per 1,000,000 gals. and the cost for power to 1 ct. per k.w.h, corresponding with that used in the other two plants.

COMPARATIVE CONSTRUCTION AND OPERATION COSTS OF SPRINKLING, FILTERS, ACTIVATED SLUDGE AND ELECTROLYTIC LIME.

	Sprinkling Filters	Activated Sludge	Electrolytic Lime
Cost to construct			
5,500,000 gal. plant.....	$431,750.00	$314,050.00	$235,000.00
Per 1,000,000 gals.	78,500.00	57,100.00	47,000.00
Per capita	7.85	5.71	4.70
Cost to Operate.			
Operating expenses	$ 17,080.00	$ 40,140.00	$ 31,385.00
Interest and Depreciation....	26,760.00	19,780.00	17,625.00
Cost per annum	43,840.00	59,920.00	49,010.00
Cost per 1,000,000 gals.....	21.84	29.85	24.50
Cost per capita	.80	1.09	.88

With the Electrolytic-Lime Process there would be produced, in the cost given, some 2,000 tons of dry sludge which if disposed of, at cost to press and dry, would show a cost

per capita to operate equal to or below that of the Sprinkling Filter.

Advantages of Process

The process has great possibilities and many marked advantages over either the Activated Sludge or Settling Tank and Sprinkling Filters. It has, of course, its limitations and is not adapted for all conditions. Among its advantages are the following:

(1) It requires a minimum of land and building space, two acres being generally sufficient for five to ten million gallon plants. Owing to the elimination of odors the plants may be located nearer to the cities and thereby obviate expensive outlet sewers.

(2) It requires a minimum of fall to be operated by gravity, 3 ft. or even less being practicable.

(3) The equipment is simple and can be operated by any mechanical engineer without much attention from the chemist. The sewage is enclosed during treatment and the treating and equipment room may be maintained as neatly as a water filtration plant.

(4) The action is practically instantaneous and does not rely upon specially prepared cultures of bacteria, which must be maintained with the greatest of care, and if destroyed or neglected will require days to restore or reproduce. There is no putrefaction or septic conditions and with average sewage both effluent and sludge are stable.

(5) Existing odors are destroyed and with ordinary care none are produced. This was demonstrated at Decatur to a remarkable degree.

(6) Under favorable condition in small installations a night flow of sewage may be stored and the plant operated in day hours only.

(7) It is not seriously affected by climatic conditions or temperatures and owing to the restricted area is well adapted to cold climates.

(8) It makes possible the most economical handling of resultant sludge, which, owing to its stability, can be handled in many ways. The present cry for conservation of land products will devise ways for utilizing it to the advantage of the producers. The free lime in the effluent will act as a cleanser of streams into which it may be discharged.

If the process were not patented and had received half the skilled study and experimentation from sanitary engineers, which the Activated Sludge Process has been given, it would have an equal standing. As in all new processes, improvements will be made to simplify and improve apparatus and lower costs. Plates have been in use now for three years and the manufacturer believes that they should last for five years under average conditions. It has winning qualities and will successfully survive the present criticisms and receive proper recognition.

FROM WORKERS IN FIELD AND OFFICE

Pettis County, Missouri, Highway Bridges

Editor of MUNICIPAL ENGINEERING:

Sir—In the November issue of MUNICIPAL ENGINEERING you publish an article by Mr. T. O. Stanley, Highway Engineer of Pettis county, Sedalia, Mo., relative to bridges that have recently been built in that county. Two of these bridges are illustrated to a limited extent, and the cost price of each is given.

We are particularly interested in the "Elm Branch" bridge, a reinforced concrete slab or girder 30-ft. span with 18 ft. roadway, built at a cost of only $569, and would greatly appreciate further details of this structure, showing general dimensions, thickness of slab or depth of girders used, and size and spacing of reinforcing.

Mr. Stanley says: "In all our work we buy the material, hire a reliable foreman and erect the bridges by force account and eliminate the contractor's profits, as we think we can do it as well as he can, and at least save the overhead expense." While it is very laudable in Mr. Stanley to save his county the profits and overhead of the contractor, he could be of further and far greater benefit to the country at large by furnishing illustrations of his bridge designs, giving methods of erection including formwork, concrete mixtures, reinforcing, methods of calculation, and other items that influence cost price. The writer feels confident that you will give space in your valuable publication for Mr. Stanley to furnish detailed information, since this is directly in the interest of the taxpayers and engineers who are "looking for the light."

Very truly yours,

J. B. MARSH,
Consulting Engineer.

Des Moines, Iowa.

(The foregoing letter was referred to Mr. Stanley whose reply follows:—Editor.)

Editor of MUNICIPAL ENGINEERING:

Sir—The Elm Branch bridge was reinforced with one 12-in. channel on each side and with six 12-in. I-beams between with one layer of "crib-wire" spread over the top of the beams and bedded in the concrete. This reinforcing wire was No. 11 with 1½x4-in. mesh. The concrete was of 1 part cement, 2 parts sand and 4 parts Joplin chats.

The form was built so as to encase the beams in concrete and arched between, so as to have only a 4-in. slab on top, thus reducing the amount of concrete, and also the dead weight on the bridge.

The detailed cost was as follows: Two hundred and forty-eight sacks of cement, $86.80; lumber for forming, $51.55; cost of sand and chats, $111.17; cost of reinforcement (I-beams and crib wire), $146.15; cost of labor including excavation, building forms and mixing and placing concrete, $173.37; total cost, $569.04.

There was nothing charged to this bridge for transporting the material from the railroad station two miles away. That was done by the patrons of the bridge free of charge. Nor was anything credited to it for salvage on the form lumber, as this was moved to another bridge and used again. This bridge was built in September, 1914.

Very truly yours,

T. O. STANLEY,
Highway Engineer, Pettis County.

Sedalia, Mo.

Experience With Motor Street Flushers in Bethlehem, Pa.

Editor MUNICIPAL ENGINEERING:

Sir—We have had very good results with motor street flushers. We find them far more economical than the old style horse-drawn flushers because of the speed with which a given

area can be flushed when compared with the old system. Despite the shorter period required, the work is done just as efficiently and the overhead charge is considerably less.

I am unable to furnish you with any statistics showing comparative cost between the old and new system as our bookkeeping is not sufficiently detailed to permit of this but we are quite sure that the cost of cleansing a street block has been greatly reduced. We determine this from calculations made from test records heretofore made but which are not available at this time. I am unable to furnish you with a photo of the flushers as I do not possess any such photo nor do I know who does. I regret that I am unable to furnish you with more information but I can safely say that our municipal officers are highly pleased with their purchase.

Yours very truly,

Bethlehem, Pa. Victor E. Tice.

Light Canvas Strips for Floating Concrete Pavement

Editor of Municipal Engineering:

Sir—During the past construction season a light canvas strip has been employed with good success for floating concrete pavement on several New York state highway contracts in Chautauqua and Cattaraugus counties.

A piece of 10 oz. canvas, about 3 ft. longer than the width of the pavement, was folded longitudinally to a width of about 18 in. and used instead of a heavier belt. By folding the canvas rounded edges were obtained which did not dig into the soft concrete.

In some cases the folded edges were left loose, and the ends of the strip rolled up to form handles for the workmen, and in others a more convenient belt was made by sewing down the folded edges and attaching wooden cross-pieces at the ends.

The operation of floating did not differ materially from the ordinary "belt method," but the light strips were handled with greater ease and rapidity than heavier belts.

The concrete was struck off with a screed of the usual type immediately after placing, and the surface floated at once with the canvas. Usually it was necessary to go over the pavement twice. On one contract, however, where the aggregates were particularly well graded and the consistency of the mixture very uniform, a single application gave an excellent finish. Floating was usually done by the same men that handled the screed. It was rarely necessary to use a hand float, except where joint strips projected above the surface.

The concrete was in all cases a 1:1.5:3 mix, using crushed stone for coarse aggregate.

Conditions Requisite to Good Results.

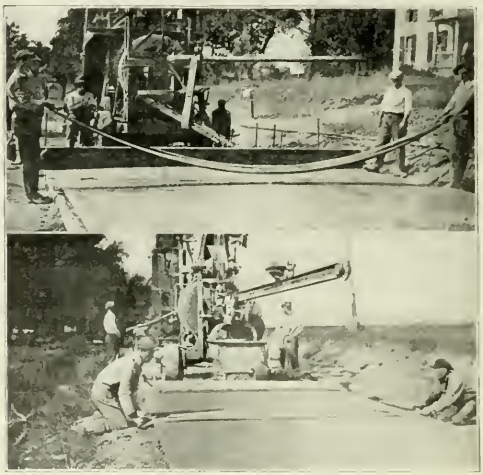
For satisfactory results in finishing pavement with the light canvas strip it was found that certain conditions must first be secured. All of these are essential, however, if a smooth surface is to be obtained by any method of finishing.

The forms must be straight and true and must be very carefully set. The top of the form guides the screed which shapes the surface.

The concrete should be fairly dry and of uniform consistency, in order to retain properly the shape given by the screed. A mixture in which the footprints of the workmen remain for several minutes without filling up is about right.

Careful screeding is of the greatest importance. If the screed "rides" the concrete, ridges result; if the concrete ahead of the screed is too low, depressions are formed. The canvas float will not smooth out these irregularities.

Provided the above conditions are fulfilled, a smooth and even finish can be easily and rapidly produced with the canvas. Very little mortar is flushed to the surface, rendering the pavement less liable to unsightly scaling under traffic. Time is saved, as except on steep grades and banked curves, where it is better to allow the concrete to become slightly hardened before finishing, the floating may be done immediately after screeding. No skilled labor is required, as the light canvas does not alter the shape left by the screed, and



FLOATING NEW YORK STATE CONCRETE ROADS WITH LIGHT CANVAS STRIP. UPPER—CANVAS STRIP USED FOR FLOATING JAMESTOWN-BEMUS POINT STATE HIGHWAY, CHAUTAUQUA CO., N. Y. LOWER FLOATING WITH CANVAS STRIP ON FRENCH CREEK—FINDLEY LAKE COUNTY HIGHWAY, CHAUTAUQUA CO., N. Y.

it is only necessary to make sure that it always touches the tops of the forms as it is worked back and forth along the surface.

These canvas strips were first used in this vicinity on the Jamestown-Bemus Point State Highway. Mr. John A. Wallace, assistant engineer, was in charge for the State Highway Department. Very truly yours,

Charles T. Fisher,

Senior Assistant Engineer New York Commission of Highways, Jamestown, N. Y.

Experience With Tractor Grading Outfits in Miller County, Mo.

The Editor of Municipal Engineering:

Sir—

Each of the two tractor grading outfits owned by Miller county, Missouri, consists of an Aultman-Taylor 30-60 gas tractor and a New Western No. 10 grader with a scarifier attachment; they were purchased in June, 1916, and during 1916 were operated under the control of the county court, but this year the court hired the tractor crew, and I have charge of the operation of the machines. The county owns the machines and furnishes the repairs, while the operation expenses, the wages of the crew, oil, etc., is met by the local road districts and private donations.

When the machines were first bought they were operated by the cheapest men that could be found, but that proved a failure, as an incompetent crew could not take the proper care of the machines and the repairs would soon amount to more than the wages of a good, competent crew. The crew at present consists of an engineer, a graderman and a helper; the engineer and graderman are paid 35 cts. per hour and their board, the helper 15 cts. per hour and board. When the machines are at work the local road overseer is along with his

crew to help pick the large rocks out of the road, blast out stumps and large stones that cannot be moved with the machines.

As to the cost per mile I can hardly tell, as we are here in the foothills of the Ozard mountains, the Osage river runs through the center of our county and a big part of our county is rough, hilly and rocky. About 50 per cent. of the roads in this county when graded have a natural hard gravel surface. Sometimes we can build a mile of road, with a 20 or 24 ft. roadway, in two days at a cost of about $50, and then the next mile may take from a week to ten days to grade at a cost of from $400 to $500; but as near as I can tell the cost per mile will average about $200, which includes the clearing of the right of way ready for the grader and the grading of the road, but does not include the culverts which, if built of concrete, will cost from $50 to $300 more per mile.

While our system of operating the tractors is not the best, it is the best we can do with our limited means; we need a cook house on wheels to move right along with our work to board the men; we are boarding them at private houses along the road at present. We can board them cheaper in a camp as a rule, and then they are always right at their work, and the engineer and graderman can go over their machines after working hours and save time, as the machines can be kept moving at least 10 hours a day, and an idle tractor is not building roads or making any money. Where the men board at private houses they may have to go two or three miles from their machines, and sometimes it will be an hour after working time before they get their breakfast and get their machines going, and the time of the balance of the crew is lost.

We have only used the machines for grading the roads, *i.e.*, cutting the side ditches and crowning the road. When the ground is hard and rocky we go over it first with a scarifier and loosen up the rock and dirt, and in case of stumps or large stones that the machine cannot move the overseer and his crew blast it out; then we take the grader and move the dirt into the road; we then use the scarifier again and keep repeating the operations until we have a good side ditch to carry off the water, and the road is well crowned.

We have a good gas tractor, but in a wooded-watered country I would advise the buying of a steam engine in place of a gas tractor, as they are cheaper to operate and more reliable, are not as apt to get out of repair and in this county steam engineers are more plentiful than gas engineers. We have had a lot of trouble trying to get good gas engineers, and wood and water is cheaper than gasoline and oil. Every community, however, would have to be governed by its own surroundings. My advice, based on our experience, would be never to buy a large grader with a scarifier attachment, but buy your scarifier or ripper mounted on a separate frame from your grader, as a machine that uses an attachment is hard to change from the grader blade to the scarifier, or vice versa, and you will find that in hard and rocky ground that the operating crew will not use the scarifier like they should, on account of its being hard to change. While a scarifier mounted will cost more than a scarifier attachment, it will give better satisfaction and will pay for itself in the time saved in changing the blades and the amount of work done. To those who contemplate buying a grading outfit, especially in a rough, rocky country, I will say do not be afraid of getting too large an outfit; I do not care how large and strong an outfit you get you will wish it was heavier and stronger when you get to using it among the rocks and hardpan gravel like we have down here in the Ozark mountains.

Yours for good roads,

S. C. KNIGHT,

Highway Engineer, Miller County, Missouri.

Tuscambia, Mo.

Gasoline Engine Efficiency

The Editor of MUNICIPAL ENGINEERING:

Sir—

Gasoline engines are used a great deal in and around municipalities for pumping water, for operating cement mixers, and for assisting contractors in general. They are used so much that it occurs to the writer that the following rule for estimating their mechanical efficiency will be welcomed. All that is necessary is to count the number of explosions made by the engine while running fully loaded and again when running without pulling any load at all. Subtract the number of explosions per minute when running at "zero load" from the number of explosions made while pulling "full load," and divide the difference by the number of explosions per minute while running fully loaded. The quotient is the "mechanical efficiency."

It is a fact that in engines of the hit-and-miss governing type each explosion represents a definite amount of gasoline or gas consumed. If the engine is running at no load and is exploding 22 times per minute, it means that 22 charges are lost per minute. If at full load the number of explosions becomes 122, it means that 22 explosions per minute are still lost and only 100 are utilized in doing useful work. It is therefore evident that the above rule is correct, and in this instance the mechanical efficiency is obtained by dividing 122 into 100, which gives us 82 per cent; 82 per cent is not such a bad efficiency, but if you can possibly make it 90 per cent, it should certainly be done. In order to obtain 90 per cent efficiency, however, the number of explosions while running at zero load will have to be as low as eleven per minute, which will be rather difficult of attainment in almost all engines of that rapidity of exploding.

Engineers need not be told how to reduce the friction in a gasoline engine. Good lubricant and plenty of it is a mighty good thing. Shafting must be properly aligned and babbitted. Nothing of a sliding nature must be too tight, nor must it be too loose if there is danger of knocking. In other words, everything must be "just right."

It is well to look into the matter of belt connection with considerable care also. A belt that is too tight will eat up a surprising amount of gasoline per day. It is much better to apply some good belt treatment to the belt and make it nice and pliable, so that it will not have to be maintained in a tight condition at all times. A very good belt test is to have the engine run at normal speed pulling nothing but the main drive belt and the main driven pulley. Suddenly close the needle valve and allow the engine to come to a dead stop. Count the number of seconds required for the engine to come to a dead stop. Then throw off the main drive belt entirely and try it again. If the belt is too tight there will be a very marked difference in the time required for the engine to come to a stop with the belt on and off. Do you get the idea? The longer the stopping time, the better.

The above two rules will be found of great value by anybody who has to do with gasoline, gas, steam or any other kind of engine. I have applied the "stopping time" method of testing even to electric motors and steam turbines. It is evident that the reasoning is based on sound logic. In fact, the writer has developed the mathematics of these methods to conclusive formulas that have checked very nicely in practical experiments.

Very truly yours,

New York City. W. F. SCHAPHORST.

Using Steam Jets to Thaw 3 Ft. of Frost

On a job handled by the Boston Excavating Co., 34 ins. of frozen clay was encountered. Embedded stones were more easily cut off than loosened. Of course this frozen crust resisted all hand tools and such ordinary means of thawing as the use of steam pipes under a canvas cover and live steam under a canvas cover proved a failure. By these means only

4 or 5 ins. were thawed out in 36 hours. The scheme successfully employed was to jet holes with a ½-in. open end pipe connected to a steam boiler by a ½-in. hose and forced steam pressure quickly melted a hole and forced small stones aside at the same time. As fast as these holes were made a ½-in. capped pipe containing four 1/8 in. holes was inserted and connected in series by short lengths of hose to steam lines run from the boiler. Twelve of these formed a series. These required 15 minutes to thaw out a section for the advancing steam shovel to excavate.

Plant Units and Lay Outs

The One-man Collapsible Culvert Form

An adjustable culvert form, two sizes of which will build 39 different culvert openings, is being marketed by the Storms Manufacturing Company. It is called the One-Man Collapsible Culvert Form, being so termed because it can be handled and collapsed by one man. It completely eliminates the use of wood bracing in the building of concrete culverts, with either flat slab tops or arched roofs. According to its manufacturers,

VIEW OF COLLAPSIBLE CULVERT FORM IN CONCRETING POSITION.

it effects a considerable saving in the building of box culverts.

The forms, which are made of iron, come in two sizes covering cross-sections of from 13x15 ins. to 36x46. For larger culvert openings, the manufacturers advocate placing two forms abreast or stacked. For a 30-ft. length four sections are used spaced 4 ft. apart. If a concrete bottom is desired, the concrete is mixed stiff and supporting planks are laid on the green concrete. When building culverts too small for a man to enter wires are attached to the cross rod and center bar in order to collapse the frame and remove it from the culvert. To keep the lumber and frames clean tar paper is laid over the forms before deposing the concrete.

A number of these forms are in service and are said to be giving a good account of themselves.

It is also claimed that by using the One-Man Collapsible Culvert Form the contractor can build box-shaped concrete culverts in far less time, at less labor cost, less lumber cost, without danger of cracking, and produce a far better job in the bargain at a saving of 25 to 50 per cent as against the concrete culvert built by means of wood bracing which has to be sawed, fitted and nailed up and then torn out when the job is completed.

Conspicuous Success of Road Building Entirely by Machinery

In these days of labor shortage a recent road building test at Peoria, Ill., has more than passing interest. It was desired to show that road construction could be carried on entirely by machinery and an unimproved trail five miles long was selected for the purpose, since dubbed "the caterpillar trail."

For the grading the principal machines employed were a Western No. 10 blade grader and an Aurora reversible grader, both made by the Western Wheeled Scraper Company. They were hitched "tandem" and drawn by a Holt 75 H. P. caterpillar tractor. An improvised tool, known as a land leveller,

BLADE GRADER AND REVERSIBLE GRADER HITCHED TANDEM AND DRAWN BY CATERPILLAR TRACTOR.

preceded by a plow and tractor drawn, also was drafted into service to help move the material.

It is a notable fact that in 80 days with these machines 120,000 cu. yds. of earth were moved in the construction of a finished roadway 60 ft. wide, absolutely without labor in the sense in which the term ordinarily is used, and at a reported cost of only 4.1 cts. per cu. yd. Roadbuilders will be interested particularly in the astonishing performance of the large blade grader known as the "Western No. 10."

This was difficult hillside work, involving heavy cutting and filling. The average cut on the high side of the roadway approximated 8 ft. and there were some cuts of 15 ft., with corresponding fills. The cutting was done with the large grader and the smaller machine in the rear worked the dirt out to one side.

The blades of the "No. 10" are so adjustable that the machine can be operated on rough ground while the tractor is taking an easier course at one side. Starting some 8 to 10 ft. from the outer edge of the proposed side ditch, the big grader made a succession of cuts until the outside of the pro-

posed ditch was reached. At each cut a comparatively smooth place was left for the tractor to travel on during the next round, while the grader climbed a little higher. By a continued repetition of this process the banks were lowered to grade.

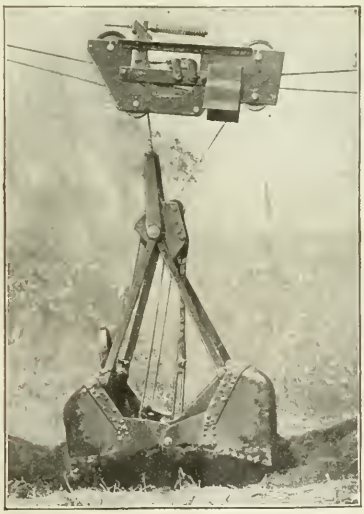
In one spot the grader sank into a mud hole so deep that the front wheels were entirely buried. It took the combined strength of two 75 H. P. tractors to pull the blade through. It was a remarkable endurance test.

In the light of a demonstration like this, to sidetrack the National Road building program on account of the labor situation, would seem the height of folly.

Locking Cable-Way Carriage for Operating Clam-Shell Buckets on Cable-Ways

Users of cable-ways operating scraper buckets or self-dumping skips loaded by hand oftentimes desire to substitute a self-loading bucket for the scraper, or skips, to extend the usefulness of the cable-way or to eliminate the labor of loading buckets. Sometimes the self-loading bucket will reduce a contractor's force on cable-way work by eight or ten men. In the past it has been necessary in such work to install additional engine drums and lines.

The Blaw locking cable-way carriage has obviated this expense. Its use enables the operator to use standard Blaw



VIEW OF LOCKING CABLE-WAY CARRIAGE.

clam-shell buckets on any ordinary cable-way designed for hand-filled buckets, without changing the cable-way engine or running additional hoisting or holding lines. This carriage also enables the user to construct a cable-way on which a clam can be operated by an ordinary two-drum non-reversible hoisting engine.

In the illustration herewith the bucket is shown suspended, in open position, from the cable-way carriage. The carriage itself is locked fast to the supporting cable by means of a clutch that is kept in engagement by the spiral compression spring. The bucket may be raised or lowered, closed or opened, without moving the carriage, by pulling or slacking on the appropriate lines.

When it is desired to cause the carriage to move, the bucket is closed and lifted and hung upon a hook pivoted to the carriage frame. The weight of the bucket then operates against the compression spring, releasing the clutch, and the carriage is free to move along the cable. By pulling on either one or other of the hoisting lines the carriage and bucket travel forward and back along the cable-way.

The system is completely automatic, operated by one man, at the hoisting engine.

Successful Demonstration of New Motor Truck

A demonstration of the Titan motor truck was made for the Pawling & Harnischfeger Co. on January 5. The truck and trailer used in making the test are here illustrated.

The grade out of the Pawling & Harnischfeger plant is 8 per cent. The driver tried to make this without skid chains and went half way up on second gear, but found, however, that in spite of the enormous pressure on the tires the wheels spun just the same. The hill was covered with snow and ice. The tires would melt the snow underneath and grab hold and pull the load up a couple of inches, but the driver finally stopped the load, applied the skid chains and started the entire 11½ tons from a dead standstill on the 8 per cent. grade. The machinery was taken from the P. & H. West Plant down to their South Plant, a distance of 55 city blocks, and the trip was made in 25 minutes. With the road conditions as they existed it would probably have taken 4 teams of horses fully two hours to make the same trip. The performance of this truck is all the more remarkable from the fact that the chassis was one of 4-ton capacity.

A Round Nose Curb Bar

The Havemeyer round nose curb bar is made with an inch radius and weighs 1½ lbs. per lineal foot. It is furnished both galvanized or ungalvanized, and is carried in stock lengths of 8, 10 and 12 ft. The manufacturers of this bar are in position to do most accurate bending. Besides stocking this curb bar in the Company's eleven warehouses, it is stocked throughout the country by various dealers and agents.

The form of anchorage in this bar is perfect, as the anchors are sheared from the web and occur every 6 ins. They extend 2¾ in. into the concrete, and are so flared and staggered as to give an excellent anchorage; especially is this anchorage of the proper type as there is a minimum of ma-

ROUND NOSE CURB BAR.

terial extending into the concrete to split or weaken it, and at the same time offering a minimum of expansion and contraction and allowing no opportunity for the water to lodge and by freezing split the concrete.

Two types of forms are furnished for supporting the bar prior to pouring the concrete. These are a flat metal form and a spring wire support.

Economics of the Motor Truck Trailer

By Leigh Lynch, Sales Manager, Columbia Motor Truck and Trailer Company, Detroit, Mich.

The first difficulty against which the truck dealer runs in considering the trailer is the fear that the total sales of trucks will be decreased by its use, but this idea is not grounded on fact, any more than was the fear of the factory

workers of some decades ago that the incoming of labor-saving machinery, would decrease the amount of work and thus leave thousands to starve.

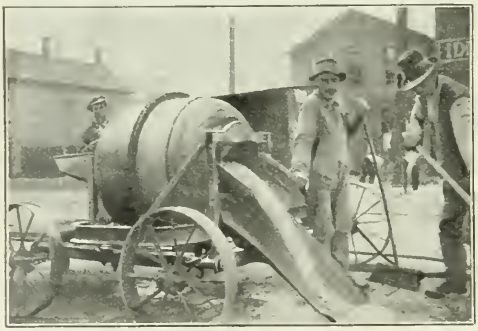
Every year records new inventions of labor-saving machinery, but the output of machinery, instead of decreasing, has increased tremendously. This line of reasoning is as true when applied to the motor truck as the fact that the motor truck is machinery. Discover and apply new methods of making the motor truck more effective, more profitable, and you will immediately increase the demand for the motor truck, just as surely as if you lowered the price of the truck. Yes, more surely; for in lowering the first cost of the truck itself you would certainly not be saving the consumer as much as if you lowered the first cost and the operation cost, too. And the trailer does both. Increasing the capacity of the truck by giving the user practically two trucks, the first cost is in reality lowered, and the operation cost for haulage largely decreased.

Another factor of considerable importance from the consumer standpoint is the fact that the motor truck will haul more than it will carry, even as a horse will draw more than it will bear. The trailer's efficiency is thus founded upon a law of nature. There is not the least doubt that the trailer will greatly increase the sales of the motor truck, even as it increases the motor truck's utility.

Contractor Adapts Building Concrete Mixer to Grouting

A contractor, George Czerwinski of Milwaukee, owning a building concrete mixer, secured a paving job on which it was necessary to have some kind of grouting machine. He didn't want to put money into a grouter just then, so by his ingenuity he made his mixer serve as a grouter.

The accompanying view shows how this contractor fixed up the mixer for grouting. He simply put the wheels on an-



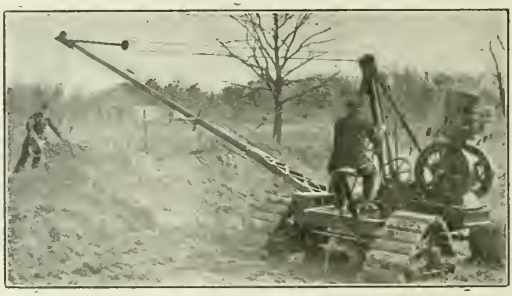
USING CONCRETE MIXER AS GROUTING MACHINE.

other pair of axles, set parallel with the drum, then he set the mixer with its axle ends resting on the new axles. This turned the mixer 90° and made it end loading. He then wired on a sheet metal discharge chute. This converted machine did fine work on a Milwaukee, Wis. paving job. When he finished this grouting job, he took off the extra set of axles and put the wheels on the stationary axles and pulled the mixer alongside a building about a mile away where he had considerable reinforced concrete to place. The whole operation of changing this machine back to a low charging mixer was accomplished in a few minutes' time.

An Improved Trench Backfiller

The problems connected with the back filling of trenches and ditches have been a big item in the prompt completion of many contracts. Originally the very slow method of shovel and team was expensive and difficult to estimate. Then with the various "private inventions" for handling the material, accidents and delays were regularly occurring.

The Parsons Company, after a number of years of careful study and experiment, have met the difficulties and inaccuracies of backfilling with a machine known as their Backfiller No. 10. This machine has answered the situation so completely for many contractors, that the present detailed description is clearly warranted. The machine is manufactured with either the Parco traction or wheel drives and is the first



POWER DRIVEN TRENCH BACKFILLER.

to be introduced with caterpillars. The traction feature allows the machine to be used in soft ground where wheel traction would mire down and has been endorsed by a great many contractors throughout the country.

The 30 ft., steel telescopic, swinging boom is another distinction which adds considerable to the desirability of the machine. The pipe construction permits the boom to be easily telescoped for any special length and is fitted to swing alongside for moving purposes. The machine is also designed so that the boom cannot be tipped under any operating conditions. An accessible worm gear boom hoist is provided for the boom suspension, attached in such position that it can be operated from the ground, the worm locking the device at all feature is the automatic scraper which has an angle adjusttimes except when the crank is turned. Another interesting ment allowing it to operate under most conditions without a man to guide it. Thus the operation of the machine is practically entirely controlled by one operator from a seat mounted on the rear end.

Such special features as the band brake on the traction drive—the rollers on the under side of the peak sheave housing, thus preventing the cable from leaving the sheave—the leather lined 15 degree cove clutches of the drums and the ball bearing collars—all combine to make the machine a very important factor in contracting work. The saving effected in the cost of filling trenches as compared with manual labor is very evident. In addition, the speed of operation and economy of labor have proven themselves to answer definitely the backfilling problems of former years.

Filtros Air Diffusing Plates Used in the Activated Sludge Process of Sewage Treatment

Filtros is a white, rigid, porous, mineral substance compossed essentially of silica, which might be termed an "artificial porous stone." The basic material is a carefully selected natural sand of exceptionally high grade averaging 99.6 per cent. SiO_2, which sand, by means of mechanical screens, is properly graded for the manufacture of the different grades.

The bonding agent employed is a synthetic silicate, fusing at temperatures above 2,000 deg. F., carefully prepared and proportioned in mixtures to produce desired results. All raw

materials entering into the composition and their manipulation during the process of manufacture are controlled scientifically to produce a product uniform in composition, structure, physical and chemical properties.

Filtros is a truly porous ware and it is not cellular. Its porosity is not obtained by any burning-out process and nothing is placed in it that is not a part of its finished state. The burning out of organic matter tends to produce a semi-closed cellular structure which may show a high percentage of voids and yet be permeable to only a limited extent, the result being a mass without uniform porosity and necessarily subject to the inherent defects of such a structure.

The plates are practically as hard as stoneware. These plates are uniform throughout and they are uniform with respect to each other. In order to insure uniform aeration over

DIAGRAM SHOWING OPERATION OF FILTROS AIR DIFFUSING PLATE.

a given area covered with plates, each plate is tested for its air passing capacity, and only those plates that pass like volumes of air are furnished for an installation. The illustration herewith gives an idea of the uniform porosity.

The plates are marketed in the standard size, 12x12x1½ ins. Plates of this size have been installed in the activated sludge tanks at Milwaukee, Cleveland, Urbana, Ill., Chicago, Ill. (Sanitary District), Houston, Paris and San Marcos, Texas, Pasadena, Cal., New Haven, Conn., Worcester, Brockton and Lawrence, Mass., and in other municipal, tannery and stockyards disposal plants.

As the readers of this journal noted in the article in the "Water Purification and Sewage Treatment" Section of the December, 1917, issue, of all the different types of air diffusers tried out by the Milwaukee Experiment Station, the filtros plates were found to be the most satisfactory. The plates are manufactured and marketed by the General Filtration Company, Inc., Rochester, N. Y.

A Simple Recording Instrument for Measuring Water or Gas to Find Leakage

The Lanham Monograph is an accurate and simple form of recording instrument for use in connection with Pitot tubes for measuring the flow of water or gases through mains or conduits. It was devised a number of years ago by Paul Lanham, in charge of water waste surveys in Washington, D. C. Extremely satisfactory results accompanied its use so it was placed on the market by the Water Works Equipment Co. of New York. The Pitot tube as used in the Monograph is an especially designed form which has features adapting it to the uses peculiar to this instrument, and superior to types heretofore used for this class of work.

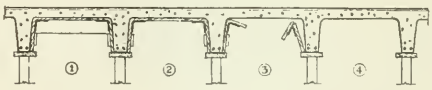
Perhaps the most important application of the Monograph is upon discharge mains from pumping stations. When so used, it gives a graphic chart showing the hourly and daily rates of flow delivered by the pumps, and these properly interpreted are of the greatest value to water works engineers, enabling them to determine whether the pumps are delivering their proper share of the water, whether the capacity of the discharge mains or pumps is being reached, the time and duration of abnormal rates of consumption, and numerous other points of interest and value.

Upon gravity supply mains, it serves as a graphic meter showing total quantity of water consumed, and hourly and daily variation in the rate. It permits a study of these rates to determine the effect of fires, main breakage, waste, or other abnormal conditions on the water supply. High percentage of flow at night when legitimate uses are at a minimum shown by the records indicate waste of water, a matter becoming of greater importance each year.

The portability of the Monograph permits of its use as a district meter in the analysis of the water consumption throughout the supply system. If conditions warrant the system may be divided into a number of districts and measurements made. These districts may be in turn subdivided and measurements on the subdivisions. The analysis along this line may be carried to the smallest territories, localizing the consumption or waste and accounting for the flow.

A Collapsible Wood Joist Form

The collapsible wood joist form here illustrated is made of the best quality of 1 in. dressed lumber. Span No. 1 shows the completed form in place; spans Nos. 2 and 3 the process of removing the diaphragm and insert, and span No. 4 the smooth concrete surface after removal. The forms are furnished for any depth or spacing of joists specified. During the first 48 hours after pouring concrete these forms provide an absolutely rigid support. Any tendency to vibration, due to accident or in the process of ordinary framing being done on top of the slab, will be resisted by these forms and no injury can be done the rapidly setting concrete. At the end of

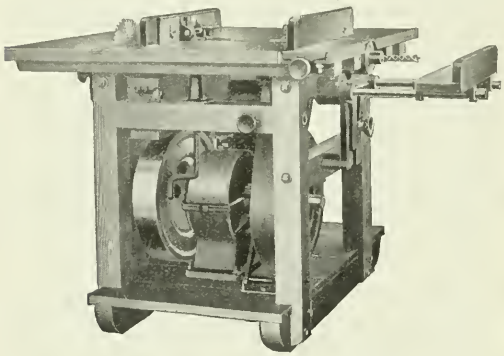


COLLAPSIBLE WOOD JOIST FORM.

this period the forms should be removed to allow the free circulation of air around the bottom and sides of the slab and joist. The price is practically the same for any depth or width of forms selected. Some of the advantages of a solid wood form are: The time saved in setting re-inforced steel, in doing all kinds of heavy carpenter work and in the speed and security with which "plumbing sleeves," "outlet boxes" and "pipe fitting" may be done. These forms permit holes to be cut, nails to be driven, or any mechanical operation customary in the use of wood. These joist forms are manufactured by the Collapsible Joist Form Co.

The Eveready Saw Rig

The contractor who has an Eveready on his job has a planing mill at his command. It is a complete machine. This Ransome-Oshkosh machine, here illustrated, performs eleven operations; cross cuts, rip saws, jig saws, band saws, tenons,



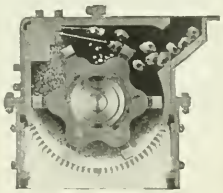
A GENERAL PURPOSE SAW RIG.

mitres, joins, bores, mortises, grinds, grooves, rabbets and sands. While the machine is substantially constructed it is light and easy to handle so it possesses the advantage of portability. It is claimed that it will do more in an hour than a man can in a day.

A Portable Crusher Popular with Road Builders

The K-B pulverizer can be obtained ready mounted on a truck. With such an outfit stone can be crushed wherever most convenient. Contractors and road builders show preference for this style of mounting.

The K-B pulverizer is an all-steel hammer mill built for service and durability. It operates at a low cost. It consists essentially of a large outer steel casing, lined with manganese steel plates, within which six U-type hammers are suspended from a central shaft. As the material is fed into the hopper the hammer whirling around at the rate of over 1,000 r. p. m., catch it and hurl it against the breaking blocks. The rebounding fragments are caught by the succeeding hammer, and again shattered against the steel blocks. For pulverizing



ESSENTIAL ELEMENTS OF THE K-B PULVERIZER.

moderately hard materials there are several advantages claimed for a hammer-mill over other types, as follows:

1. It takes a larger piece and crushes it to a finer product than any other single machine. In some cases it eliminates the work of the preliminary crusher; in other cases it does away with additional screens and separators.

2. Both the initial and also the operating cost of a hammer-mill is less than that of other types of reduction machinery. This is because it is simpler in construction and consumes less power than other machines doing similar work.

3. The K-B Pulverizer will often handle wet or damp materials, thus eliminating the cost of drying before pulverizing.

The machine is belt-driven and any type of engine or electric motor can be used to run it.

A Satisfactory Sand-Sweeping Machine

The sand-sweeping machine here shown, used by the Asphalt Block Pavement Co., Toledo, Ohio, is horse-drawn and derives its power from the large driving wheels, which, operating through the sprockets and chain and bevel gears,

SAND SWEEPING MACHINE USED ON PAVEMENT CONSTRUCTION.

causes the brushes to rotate about the vertical shaft. The rotary movement of the brushes, as the machine advances, sweeps the sand into the cracks betwen the blocks most effectively. When it is desired to move the machine to another job, the clutch can be thrown out and the brushes raised. It can then be moved by hand if necessary.

Heltzel "Lightning" Loader Skips

In these days when the contractor is so concerned in saving labor and time, owing to the scarcity of the one and the value of the other, loading devices are proving exceedingly helpful.

The Council of National Defense, working in collaboration with the Government, have increased the demurrage charges on cars to such an extent that the contractor is forced to pay a good stiff price for any delays in handling his material. It is, therefore, imperative, not only from a patriotic but from a selfish standpoint, to use every means of reducing the cost of handling material by the installation of every practical and economical means available.

The "Lightning" Loader Skip is offered for this specific purpose. It is easily and quickly attached to any type of railroad car. It decreases enforced idleness by ever inviting the shovelful. It instantly stops delays. It keeps the men on the trucks and teams constantly on the move. This loader skip is adjustable to height and consequently a truck of unusual height is not difficult to load.

The objection to devices of this kind, in the past, has been the excessive weight and difficulty in installing on the car. This has been eliminated by the unique construction offered by the Heltzel Steel Form & Iron Co., of Warren, Ohio, in the loader skip here described. The pan or tray, holding the materials is slid out over the top of the two steel structural brackets, strongly constructed, and is held in place by steel shoes which fit into the upturned end of the bracket. The steel sideboards and doors are independent units and are attached as such. The door opens by gravity, and acts as a re-

tard, preventing an overflow of materials across the wagon or truck, thus eliminating spilling of the materials.

The loaders are in use by the United States Steel Corporation, the Standard Oil Company, the Westinghouse interests, and by the U. S. Government, principally on cantonment and other rush construction jobs.

ADVANCE INFORMATION ON BIG JOBS

The Proposed Military Roads of Texas

By George A. Duren, State Highway Engineer, Austin, Texas

The great need of military roads has suddenly made itself manifest to the War Department as well as to the general public. It is now a matter of common knowledge that the excellent highways of France made it possible, with the use of motor trucks, to change the results of the war from a sure defeat of the Allies to a final victory.

Texas Has First Hand Knowledge of Importance of Military Roads

Pershing's expedition into Mexico brought clearly to our attention the important role that motor transportation would hereafter fill in modern warfare. Great troop movements have already taken place in Texas over our highways, and it is telling no military secrets in calling attention to the fact that the Sixth Regiment of Cavalry was moved over them from Marfa to San Antonio, a distance of 450 miles, and that at the same time a full regiment, being the Eighth Cavalry, was moved over the highways from Fort Bliss, at El Paso, to Marfa; and that a regiment of engineers went overland from San Antonio to Corpus Christi; and that an immense army wagon train traveled overland from Fort Sam Houston, at San Antonio, to Fort Sill, at El Paso; and that at this time a trip is being made by motor ordnance repair trucks on a tour of the Texas border forts.

Points That Should be Connected with Military Highways

There is now a constant stream with traffic of troops and equipment, and military traffic over our State Highways. On account of the enormous resources of Texas and on account of its climate, enormous numbers of soldiers are being trained within the borders of the state. Large bodies of men and a tremendous amount of army equipment with vast expenditures of money are now found on every hand within this state. Some of the points of mobilization and training that should be connected up with first class military highways without delay are as follows:

Fall Field, Aviation Camp, Wichita Falls; Love Field, Aviation Camp, Dallas; Taliaferro Fields, Nos. 1, 2 and 3, Aviation Camps, Fort Worth; Camp Bowie, Army Post Headquarters of 36th National Guard Division, at Fort Worth; Camp McArthur, at Waco; Hicks Field, Aviation Camp, at Waco; Camp Logan, Houston; Fort Crockett, at Galveston; Camps Travis, Bullis, Stanley, Morse, Fort Sam Houston, at San Antonio; Aviation Fields: Kelly Field No. 1, Kelly Field No. 2, Brooks Field, and Balloon School, San Antonio; S. M. A. Aviation School, at Austin; Signal Corps School, at Bryan; Fort Brown, at Brownsville; Fort Ringgold; Fort McIntosh, at Laredo; Marfa, Headquarters Border Guard; Army Post at Fort Bliss, El Paso, Headquarters of Western District of Southern Department; and Ship-building plants at Houston, Orange and Rockport.

All of the most important points of concentration of troops in the state, as mentioned above, with a few minor exceptions, are situated in the heart of the industrial and agricultural portion of Texas, along with the greatest concentration of the population of Texas.

The System of Military Highways Planned

The map shown herewith outlines a system of military highways planned for the purpose of conserving the resources of Texas and for the purpose of concentrating our efforts in order to accomplish the construction and maintenance of the most vital arteries of motor vehicle transportation of the state. In my opinion, the highways shown on the map are of vital importance to the military and also to the industrial welfare of the state of Texas, and to the nation.

The improvement of those highways designated on the map by solid lines, is an immediate public necessity. The entire system of highways shown constitutes a system of important military highways, but in order to accomplish the desired results we must begin with the most important and concentrate our efforts on these for the fulfillment of our purpose. The roads shown by parallel lines are of great military and economic importance, but their construction should not be allowed to interfere with the construction and maintenance of the system shown in solid lines until their construction is accomplished. We should refrain from interfering with shipments of coal and other shipments essential for war purposes. Our plan may be submitted to the War Council for their consideration, and if, in their opinion, they deem it necessary or desirable to co-operate, we would gladly receive any assistance they may extend. I suggest that they do extend to us aid either by alloting to this work necessary railway service, or by alloting, in aid of this work, funds.

Raising Funds

In order to raise funds for the construction of this system of military highways, I suggest:

(1) That the military importance of these roads is sufficient to warrant their construction out of Federal funds as a war measure. The War Department is fully advised of the facts relative to army camps, aviation fields, etc., served by this system and we respectfully urge that it take over the construction and maintenance of this system or a system of its own designation.

(2) The national importance of these roads as post roads is sufficient to warrant a liberal interpretation of the law by the Office of Public Roads and Rural Engineering and a liberal grant of shipping facilities for their construction.

(3) This system is of sufficient state importance industrially and as a measure of home defense to warrant not only the most liberal interpretation of the State Highway Act of 1917, but of sufficient merit to warrant a state bond issue.

(4) Each part of this system lying within the respective counties and cities traversed is of sufficient local importance as an economic and industrial measure to warrant its construction entirely out of local funds.

Suggested Petitions

I am of the opinion that petitions, if strongly urged, as follows, might be granted:

First, petition to Secretary of War Baker and to Railway Director McAdoo, that necessary railway facilities be allowed for construction and maintenance of this system of roads and that the improved parts of them adjacent to army posts that

have been destroyed by army traffic be restored and maintained by the War Department.

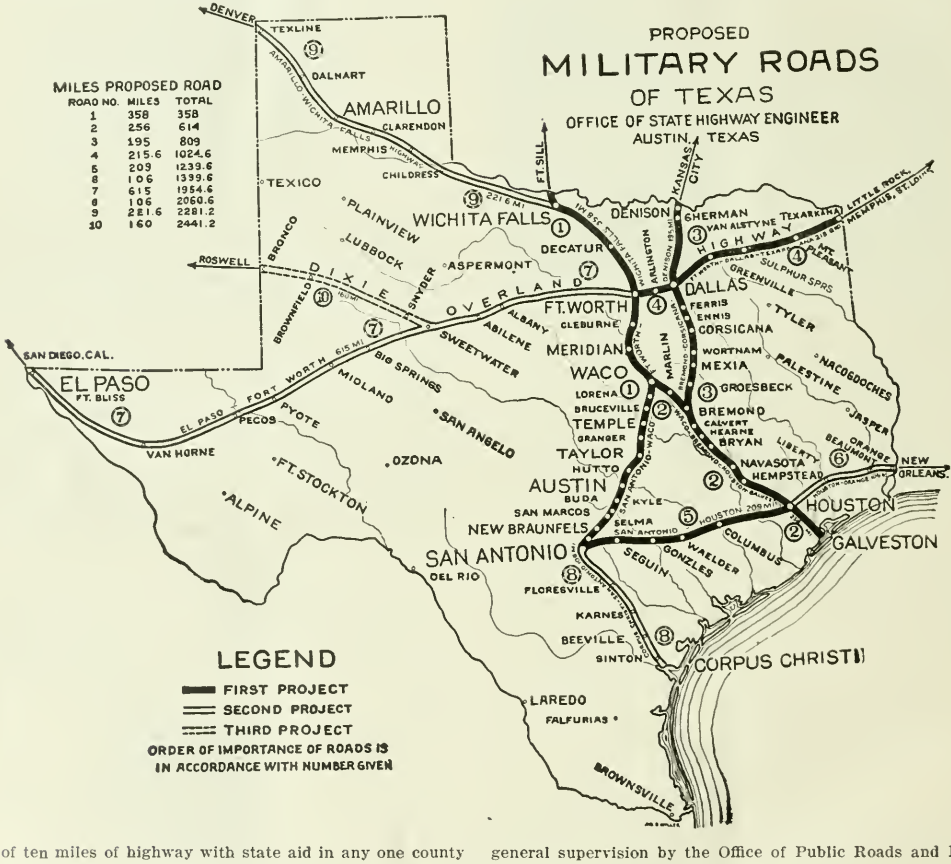
Second, to the Secretary of Agriculture, that this system be declared eligible to Federal aid allotments in all of its parts since they are either used as post roads or will probably be used for carrying United States mails after construction, and to petition him that on them no further formalities be required in the way of proof from postmasters and mail carriers in certificates, etc.

Third, to urge the state officials to act in accordance with the most liberal interpretation of the State Highway Act, since, as I understand, it was the intent of the framers of the State Highway Act of 1917 to restrict aid to the construc-

during the war, I endorse in all things except for the necessary bond issue and road district bond issues required to accomplish the construction of this system of highways. I suggest that these bonds be designated as "Liberty Highway Bonds" and that they be sold in Texas, if possible, and that an attempt be made to sell them in accounts pro rata with the assessed wealth of the individuals, placing 40 per cent. or more of the bond issue of the county in question with the people of the county and placing 60 per cent. with the people of the state of Texas pro rata with their assessed wealth.

Organization

I recommend that the proposed construction be in charge of the State Highway Department subject to inspection and



tion of ten miles of highway with state aid in any one county in any one year not to exceed one-fourth the total cost of construction of forty or more miles in the county.

Federal Aid to Counties

I should be glad to recommend to the State Highway Commission that Federal aid be granted out of available Federal aid funds to cover not less than 40 per cent. of the total cost of the system and that state aid be granted to an amount of between 20 and 25 per cent. of the total cost of them, except where it would exceed one-fourth the cost of building the most expensive forty miles in the county; and I would recommend that county bonds or warrants be issued to cover the balance of cost of construction.

The recommendation of the Federal Reserve Banking Board that improvements requiring bond issues be suspended

general supervision by the Office of Public Roads and Rural Engineering. I would call on the county officials to turn over to the State Highway Department for their control in the proposed construction all county road machinery, teams and other equipment, or as much thereof as may be required. Such counties to be reimbursed by schedule of rental charges such as would be equitable, and that contractors' organization and equipment be in like manner used on same basis of pay as that of counties furnishing similar organization, tools and equipment. In this connection, the free labor employed thereon might be advantageously regulated on a military basis and trained to the duties of highway engineering corps for active war service. If found advisable, state prisoners could be used and in addition thereto county prisoners wherever legally possible. For later consideration, the use of

Federal prisoners may be considered with the view of providing employment for our future supply of war prisoners.

The first project contemplated includes 1,233.6 miles of highway. The second project for approximately the same mileage. All of these highways lie near and adjacent to one or more railways. Numerous gravel pits and rock deposits are found adjacent, and this system of roads can be constructed with a minimum expenditure; in car miles, in team miles, in labor days and in materials used. This system is in part already constructed and the completon of it for each dollar expended will accomplish as much or more in results as would the construction of any other highway in the state. I am of the opinion that we could do no more patriotic thing than to accomplish the construction of this project without delay.

News of Prospective Work From State Highway Departments

The present outlook for highway construction work is here given as reported to the editor by officials of the state highway departments:

Illinois

Clifford Older, Chief Highway Engineer, writes as follows:

"Aside from the restrictions which war conditions place upon all construction work, the prospect of highway improvement in this State was never better than at the present time. The funds available from Federal Aid, county bond issues and the regular State aid program amount to approximately $10,000,000 and no doubt under normal conditions, only the ordinary difficulties would be encountered in arranging for the improvement of the roads this amount would cover.

You are no doubt familiar with the plan proposed at the Richmond convention of the American Highway Officials Association which, in brief, provides that each State Highway Department furnish to the executive committee of the Association, an outline of the maintenance and improvement work contemplated for 1918, listed in the order of importance of the various projects. The executive committee of the Association will then present the entire matter to the Highways Transport Committee of the Council of National Defense and it is believed that in this way a logical plan for highway improvement, which will fit in with the needs of the Federal Government, may be carried out.

It seems to be generally recognized that highways connecting industrial centers with each other and with shipping terminals may be used to great advantage during the period of the war. It seems, also, that many improvements may be made during the period of the war which will provide highway transportation facilities of this character that do not exist at the present time. We are at the present time engaged in shaping our program in so far as the restrictions on funds will permit in accordance with the above outlined plan.

New Hampshire

Fredric E. Everett, Commissioner New Hampshire State Highway Department, Concord, writes:

The State has an appropriation of $200,000 for trunk line construction, besides an annual appropriation of $125,000 for State Aid. All work, however, both trunk line and state aid is done on a joint account basis or really a state aid basis. The difference between trunk line construction and state aid construction is that the state pays a larger proportion of the entire cost on trunk line work than they do on state aid work.

Just what will be done the next year it is impossible at this time to say as we cannot tell what towns will apply for state aid until after their annual town meeting which, in New Hampshire, comes in March.

Last year the state built only about two-thirds as much road as they did the previous year and there was a larger appropriation. The state is prepared to meet all the towns in the matter of appropriations and to proceed with the work as fast as possible.

The matter of road material does not seriously affect us, as we use most all local gravel and stone in our construction work. However, cement, binders, etc., have to be shipped from outside of the state. Priority orders and embargoes would affect us in so far as they refer to these materials.

We are making plans for our maintenance work, and will do everything possible to keep the roads already built in good condition.

Ohio

R. C. Watts, Office Engineer, writes:

The demand for road improvements is greater than ever, but the prospects at this time are not first class for placing contracts. Therefore, we are unable to give you what will be improved this year.

We are, however, proceeding as usual to plan future work which is done in cooperation with the counties, program for which is not as yet completed.

West Virginia

T. S. Scanlon, West Virginia State Road Commissioner writes:

We have laid out in this State practically 4,600 miles of what the law describes as "Class A" roads. This is an intercounty system, laid off to connect every county seat and important commercial center with every other county seat and important commercial center. We approximate the cost of this 4,600 miles to $100,000,000, $20,000,000 of which has been provided and partially spent, possibly more than one-half of it. The counties of our State have this year laid a levy and are now collecting it; known as "Class A levy," of about $2,000,000, and this, you understand, is outside of a special levy that each county may lay for the coming year for the purpose of building lateral or district roads. We expect a number of the counties to bond themselves for road purposes during the early spring, probably to an amount that will be at least as much as three or four millions of dollars. This combined with the money on hand in a number of the counties and the "Class A levy" above mentioned and which has been laid by all of the counties will give this State considerable money to spend in the direction of road building and road improvement in the year 1918.

We will have besides this, in the way of State and Federal Aid, probably five or six hundred thousands of dollars that will be distributed pro-rata among the counties, based upon the mileage in each county of the "Class A" roads above mentioned.

At this time we cannot give you much detail as to what is going to be done, as we are not sure what is going to happen in connection with transportation matters. We feel satisfied from the correspondence that we have had with the National regulating power that as soon as possible road materials will be taken off the restriction list. However, we have but very few counties in this State that we cannot spend considerable money in, in the way of grading and drainage and we have in very many sections of the State good local material outside of probably the binder, should we want to use other than water bound construction.

We feel sure that the people all over the country have become awakened to the necessity of making good roads, especially the through system like the one we have laid out in our State and our people are not an exception to this rule. The writer has had long experience in road building in several of the States and he can positively state that he has never seen as much good road sentiment among the people in any community that he happened to be in as among the people of this State at this early stage of road construction in West Virginia.

So you may rest assured that West Virginia will go ahead in this year of 1918 and do at least as much road building as in the past years, if not more.

Indiana

Wm. S. Moore, State Highway Engineer writes:

The Indiana State Highway Commission has sufficient money in sight to build approximately two hundred miles of Main Market Highways. We are preparing plans and specifications and making the surveys for these improvements, and are expecting to carry out, if possible, all of this work in 1918. We feel that no work should be done, at this time, except on the Main Market Highways, and we are, therefore, centralizing our forces on these roads. We think that now is not the time for promiscuous road construction, but we cannot allow main roads to become impassable, and for that reason we expect to proceed to put these roads in repair and improve same wherever it is possible to obtain material.

We are making an extra effort to use local material as much as possible.

We are submitting to the Transport Committee of the National Council of Defense a list of these main roads, together with the amount of material which will be required to be shipped for maintaining and improving during the year of 1918, and asking that the embargo on open top cars for this road material be lifted.

You will recall that at the last session of the State Highway official meeting, which was held in Richmond, Virginia, which requested the Highway officials to furnish information as above stated, and this Commission expects to comply in every way with these resolutions and to co-operate with the State Commission of Defense in any program which they think advisable.

Pennsylvania

J. Denny O'Neil, Highway Commissioner of Pennsylvania, has completed a tour of the various counties, which was taken for the purpose of holding conferences with Boards of County Commissioners and other local authorities regarding future road construction and improvement and to secure cooperation, if possible, in a plan, whereby they will join with the State in financing the improvement of highways. In most instances Commissioner O'Neil was successful and an effective road-construction plan is being worked out by which many miles of important roads in the State will be reconstructed, the State and local authorities each paying one-half of the cost.

Despite existing abnormal conditions—scarcity of men and the high cost of everything which enters into the construction of an improved road, together with the lack of freight car facilities for the haulage of road materials—it is Commissioner O'Neil's intention to go ahead with the plans which he is formulating with local officials throughout the State, for the improvement of roads that, eventually, will link up into a complete system which will connect all of the county seats.

With so many factors militating against a big road construction policy, Commissioner O'Neil states that it is hard definitely to say at this time what the Department will be able to undertake along construction lines during 1918. But he is of the opinion that all matters should be shaped up in such a manner that when conditions begin to assume a more normal aspect, there will be no delay in the commencement of work to improve those roads which are to form a part of the proposed system.

Commissioner O'Neil has declared for a strong maintenance policy, stating that all roads which have been built must be maintained adequately at all costs.

Virginia

G. P. Coleman, Road Commissioner of Richmond, Virginia, writes:

The plans for the coming year for road work in this State have not assumed definite form. We are, however, recommending to the Legislature our usual appropriations for the coming year; that is

State money aid	$200,000
State convict labor aid	250,000
Maintenance (approximately)	600,000
Contingent fund for this department	38,000
To meet the Federal allotment	330,000

In other words, it is our plan to carry on as far as possible our usual amount of road work, and in addition thereto between six and seven hundred thousand dollars of work as covered under the Federal aid bill, believing that in doing this we are offering the best service we can to the nation for the successful prosecution of the war, since we feel that the highway transportation in America will play an important part in the ultimate victory for this country in France.

North Carolina

W. S. Fallis, State Highway Engineer, Raleigh, N. C., writes:

The following outline is of work that we hope to do under Federal aid during the next eighteen months, naming the counties in which construction is proposed and the roads:

It is the purpose of the State Highway Commission first to complete the worst sections of through state roads, with the best construction the financial situation in the sections of the state through which the roads of the state are to be built will permit.

A road through Person county to the Virginia State line, a distance of from 25 to 30 miles is projected, and we expect to complete this, if bonds can be sold by the county to provide for the county's share of this work.

A road in Wilkes county, which is a link of a through road connecting Tennessee with northwestern North Carolina will be built. This road will probably cost somewhere in the neighborhood of $40,000, and is about 40 miles long.

We are nearing the completion of a road crossing the Blue Ridge in Henderson county known as the Hickory Nut Gap road, one of the most scenic roads in that section of the state of North Carolina, passing the famous Chimney Rock and across Hickory Nut Gap, bringing into full view at many points the famous mountain peaks of this section, among them Mt. Mitchell, one of the highest peaks of the Blue Ridge mountains.

A road is also being constructed across the Blue Ridge, and is nearing completion, along the Southern Railroad through McDowell county. This is also a beautiful piece of mountain scenery, and follows that wonderful bit of railroad engineering that carries the Southern Railway across the Blue Ridge and down the French Broad river to Knoxville, Tenn.

Southwest of the Buncombe county line, along what is known as the Murphy branch in the Hiwassee, Tennessee and Tuckaseegee valleys, much road construction is in progress, which when completed will open up to the tourist a through road from Asheville to Atlanta, and make it possible for him to visit what is perhaps the most beautiful mountain scenery in all the eastern part of the United States.

Guilford and Mecklenburg counties have ambitious programs for road construction during the coming summer. A bond issue of one million dollars is being agitated in Guilford county, and much bituminous road will be constructed in Mecklenburg county during the coming summer.

Mecklenburg county is the leading, or rather the pioneer road county of the South, having constructed hundreds of miles of waterbound macadam road during the days when waterbound macadam represented the best type of road construction. Owing to the failure of this county properly to maintain these roads their system has become practically worn out, and reconstruction on a large scale must be undertaken.

Eastern North Carolina is beginning to wake up also to the value of making expenditures for the construction of roads, and Wake county is contemplating a considerable expenditure for concrete road work; and some concrete road work is being planned in Lenoir county. Beaufort county is also discussing the expenditure of considerable sums on this class of work.

Eastern North Carolina, especially the Coastal Plain, is practically devoid of suitable road surfacing material, and it seems likely that they must resort to high class road construction as rapidly as the financial situation will permit.

New Hanover county has already constructed roads that are perfectly satisfactory to the traffic of this county, which is largely pneumatic tired traffic, and iron shod traffic of rather light unit weight. They have excellent roads, however, of bituminous surfacing and bituminous treatment, and taken as a whole are probably better fixed in roads than any other county in the State.

The aggregate of road construction in other sections of the State will amount to between three and four million dollars during the coming year, if the plans now being promoted are carried out.

The Tex-O-Kan Highway Organized

Another interstate highway, called the Tex-O-Kan highway, has been organized. The organization meeting was held at Abilene, Texas, recently. The highway will extend from San Antonio, via Kerrville, Paint Rock, Ballinger, Abilene and Quanah, Texas, to Altus, Okla., and thence into Kansas. Delegates from every county along the route attended the organization meeting and indications are that within a year this will be a hard surface roadway from one end to the other.

The greater portion of the route will be eligible for both federal and state aid. Officers of the Tex-O-Kan Highway Association are: J. A. Walker, Altus, Okla., president; Hon. E. M. Overshiner, of Abilene, vice-president, and J. W. Golston, of Quanah, Texas, secretary.

Eight Southern States Will Spend $74,000,000 on Road Construction This Year

Estimates based on figures from the highway departments of eight southern states indicate that $76,000,000 will be expended by those states on the construction of permanent highways and bridges in 1918, says the Southern Construction News.

The states included in the list are shown in the following tabulation with the estimate of the amount to be spent by each state:

Alabama	$4,000,000
Arkansas	5,000,000
Louisiana, available	9,000,000
Mississippi	2,000,000
Missouri	6,000,000
Oklahoma	2,000,000
Tennessee, from all sources, available	16,000,000
Texas, from all sources	30,000,000
Total	$74,000,000

Alabama

In Alabama it is safe to predict that more than $1,248,000 will be used in road construction since this amount of federal aid is available. The usual state aid is $154,000. Counties taking state aid put up dollar for dollar. Everything considered it is probable Alabama will spend $4,000,000.

Arkansas

In Arkansas construction is under way or the organization is perfected to a point ready to begin construction on 868.88 miles of road, representing an expenditure of $5,965,239.21. Throughout 1917 petitions for surveys have come in faster than the department has been able to furnish engineers, and as yet there seems to be no let-up in requests for same, there being now on file petitions asking for surveys of 250 miles of road.

Louisiana

In Louisiana, in addition to federal and state aid funds, $7,825,000 in bond issues have either passed or elections have been called as follows:

Vermillion Parish	$ 600,000
St. Mary Parish	400,000
*Terrebonne Parish	150,000
*LaFourche Parish	150,000
*St. James Parish	250,000
*West Baton Rouge Parish	150,000
*Point Coupee Parish	170,000
Lafayette Parish	300,000
*Acadia Parish	400,000
Evangeline Parish	140,000
*Jeff Davis Parish	500,000
*Beauregard Parish	600,000
*Calcasieu Parish	900,000
*Allen Parish	115,000
*Vernon Parish	240,000
*Sabine Parish	40,000
*Natchitoches Parish	250,000
*De Soto Parish	250,000
*Red River Parish	150,000
*Caddo Parish	260,000
*Bossier Parish	150,000
*Grant Parish	150,000
Winn Parish	300,000
*Rapids Parish	250,000
*Quachita Parish	500,000
*Avoyelles Parish	100,000
*Caldwell Parish	140,000
*Assumption Parish	40,000
*Ascension Parish	80,000
*Baton Rouge Parish	100,000
Total	$7,835,000

*Have already been passed and the money is ready.

Mississippi

X. A. Kramer comments on conditions in Mississippi as follows:

"Approximately $7,500,000 is being expended on new road construction, and this amount will be expended within the next eighteen months, if cars are made available. Many counties are contemplating the issuance of additional bonds for improved roads. The bonds, however, are not selling as well as they did a year ago. Separate road district bonds which, twelve months ago, were sold bearing interest at 5 per cent. per annum, are now being sold at 6 per cent., the public seeming willing to pay the high rate of interest in order to have the roads built promptly. In those counties where local surfacing material is available the work is not being delayed. The prospect for a good crop throughout the state has stimulated the demand for improved roads."

Oklahoma

T. F. Hensley, of the Oklahoma State Highway Department, comments on the road situation in that state as follows:

"The forecast for 1918, after the first depressing influence of our entry into the war has passed and our lost equilibrium, occasioned by the draft, is regained, seems to be reassuring. It would seem that the high cost of material will be offset by the unprecedented prices received for all kinds of farm products. It is apparent to all that a bushel of wheat or a measure

of any of the products of the soil will buy more bridge and road material than ever before in the history of the world. Then why should we pause in our road construction? is the question the producers of all wealth are asking. They see the necessity for good roads plainer now than ever before."

Large Federal Aid Projects in Oklahoma

The Ozark Trail was the first Oklahoma project to apply for federal and state aid. The promoters of this highway will soon construct a $150,000 bridge across the South Canadian river at New Castle.

The second project in point of magnitude now in sight is the construction of 40 miles of gravel road through McCurtain county on what is known as the "Broken Bow and Smithville highway."

The third project is the construction of five miles of asphalt macadam in McIntosh county, on the Jefferson highway—the king of all highways in Oklahoma.

The fourth project that will receive federal aid is another link of 18 miles in the Jefferson highway, in Ottawa county, the banner zinc producing county of the New Southwest. This stretch of 18 miles of this highway will be constructed either of concrete or asphalt macadam.

The fifth federal project is 5 miles of concrete or asphalt macadam in Oklahoma county, on the Ozark Trail, commencing at the Santa Fe railroad, on Twenty-third street, and extending east past the new Capitol building 5 miles into the country.

The sixth and last state and federal project in sight is a 6-mile stretch of concrete or asphalt macadam in Creek county, on the Ozark Trail, near Sapulpa.

County and Township Plans

In addition to the above state and federal projects, many counties and a few townships have voted large blocks of bonds and are now engaged, or soon will be, in surfacing dirt roads and in constructing permanent bridges and culverts of stone or concrete.

Foremost among these is Okmulgee county, which has issued and sold at a premium $800,000 in bonds, to be employed in general hard-surfaced road work.

Carter county has voted a $200,000 bond issue and has $68,000 of gross production oil tax to her credit, all of which will be used for general road betterment and in hard-surfacing dirt roads.

Hughes county has issued $600 a mile for the construction of 14 miles of mountain state roads. This road will be constructed of whatever material is found convenient and at hand. In order to piece out the bond issue and make it cover the work planned, the county commissioners have contracted with the State Board of Affairs for a prison camp of 100 men and 40 teams to do the work.

In Sequoyah county 9 townships have voted bonds ranging from $6,000 to $20,000 each, and County Engineer Wheeler says that every township in his county has given value received in permanent concrete and stone culverts and in well-surfaced and perfectly drained dirt roads.

The townships adjacent to Fort Smith, Ark., have built 30 miles of the finest dirt road to be found in the state. The city of Fort Smith, in order to show its appreciation of this work, and to gain the trade of this section of Oklahoma, is building a fine $500,000 concrete bridge across the Arkansas river. This bridge, which is a free bridge, is the gateway of the Albert Pike highway into the state of Arkansas.

Some Major Construction Projects of the Sanitary District of Chicago for 1918

President Charles H. Sergel of the Sanitary District of Chicago has given out a brief statement of the construction projects contemplated for this year.

The Calumet-Sag channel, which, when completed, will convey the sewage of the southern part of the city and the Calumet district away from the lake into which it now empties, to the main channel, will be completed during 1919, barring unforeseen delays. The Evanston sewers begun last spring probably will be finished by the end of 1918.

Pumping and Sewage Treatment Plants

With the completion of these projects the channel and sewer construction of the district practically will be ended. There still remain many pumping stations and other adjuncts of these works to be built. The trustees have had under consideration during the year plans for a pumping station in the Calumet district to pump sewage into the new channel, a pumping station in the Desplaines river district, and one at Evanston. Engineers are now working on plans for these structures and if finances of the district permit, construction work on them will be begun next year. In addition to these a sewage treatment plant to purify sewage before it enters the new channel is contemplated for the Calumet district.

A similar but smaller plant will be built in the Desplaines section. A site for the latter, containing twenty-seven acres, south of Twelfth street and west of the Desplaines river, has been bought and the trustees propose to begin work on the plant during 1918.

Bridge Work

Inability to get steel and high prices of materials of all kinds entering into bridge construction held up the district's bridge building program last year, and the same conditions likely will obtain during 1918. Bridges at California avenue, Crawford avenue, Cicero avenue, Harlem avenue, and Twelfth street are under consideration and will be built as soon as conditions will permit.

Activated Sludge Plant for Treating Stockyards Wastes

In addition to the work mentioned the district has been in negotiation with the stockyards interests concerning a plan to take care of the yards wastes and prevent them going into the main channel without treatment. These wastes are estimated as equivalent to the sewage of 1,000,000 people and place a heavy burden on the main channel.

The meetings with the representatives of the packers have resulted in a decision to build an activated sludge plant for the treatment of stockyards wastes. Negotiations for a site are under way and a proposal has been made to fill up Bubbly creek to form a portion of the site. It is estimated that the necessary plant for the packing house wastes will cost in the neighborhood of $4,000,000. It is proposed at first to build a unit plant that will treat one-thirty-second of the sewage, with one-fourth of all the sewage screened, at a cost of about $200,000. The question of the division of cost between the sanitary district and the packers has not been decided.

The principal requests of the engineering department for construction work during 1918 follow:

Evanston pumping station	$ 85,000
Desplaines river pumping station and treatment plant	140,000
Calumet pumping station	400,000
Ninety-fifth street pumping station	50,000
Desplaines river sewer	100,000
Evanston sewer	525,000
Calumet sewer	1,495,000
Calumet-Sag channel	1,124,000
Main channel improvement	500,000
Total	$4,419,000

Sheridan Road, Connecting Chicago and Milwaukee, to be Completed in 1918

By Ray Smith, President of the Sheridan Road Improvement Association of Wisconsin

There is every indication that the famous Sheridan road, connecting Milwaukee and Chicago, along the lake front, will be completed in 1918. This is based on the information received by the officials of the Sheridan Road Improvement association of Wisconsin, which has been in existence since 1915, to assist in bringing about the completion of the much-needed highway.

This road, when completed, will make it one of the famous highways in the country and will tend to stimulate business between the two big cities of the middle west, and open an avenue for travel that will bring thousands of tourists into Wisconsin, the "playgrounds of the west."

The following federal aid improvements on the Sheridan road are contemplated in Wisconsin for 1918:

Milwaukee County

Milwaukee county: The improvement by grading, draining, culverting and surfacing with concrete 18 ft. in width of a portion of the Milwaukee and Racine (Sheridan) road, commencing at the south federal construction limits in the city of South Milwaukee on the southwest quarter of section 11 T 5 N, R 22 E, and extending thence south about four-fifths of a mile to the north end of the present concrete road at about the center of section 14 T 5 N, R 22 E. The estimated cost of the proposed improvement is $18,000.

Racine County

Racine county: The improvement by grading, draining, culverting and surfacing with concrete 16 ft. in width of a portion of the Racine and Milwaukee (Sheridan) road beginning at the Milwaukee county line at the northwest quarter of section 1 T 4, R 22 E, and extending south about three and one-quarter miles to the north end of the existing concrete pavement in section 18. The estimated cost of the improvement is $51,000.

The improvement by the relocating, grading, draining, culverting and surfacing with concrete 16 ft. in width of a portion of the Racine and Kenosha (Sheridan) road, commencing at the south end of the present concrete in the southeast quarter of section 29, T 3 N, R 23 E, and extending thence about 1.2 miles to the south county line the south center of section 32, T 3 N, R 23 E. Estimated cost $24,000.

Kenosha County

Kenosha county: The improvement by the grading, draining, culverting and surfacing with concrete 16 ft. in width of a portion of the Kenosha and Chicago (Sheridan) road, commencing at the south end of the concrete road contracted to be built in 1918, and extending about one and one-half miles to the state line. Estimated cost of this project is $26,000.

The cost of all these projects will be borne: One-third by the federal government, one-third by the state and one-third by the county in which the construction lies.

Cook and Lake Counties

For the Illinois side, Cook county voted a $1,000,000 bond issue for the roads. Lake county recently voted a bond issue of $500,000 and the county clerk of that county states that this will be utilized this year to build a road which starts at the highway running northward to the Lake county line in Cook county and runs easterly into Waukesha, and thence northward over to the Sheridan road to the Wisconsin state line, completing the road in Illinois.

Sanitary District of Chicago Offers Federal Government $475,000 to Build Controlling Works to End Lake Levels Controversy

Fear that the United States government may succeed in its efforts to force the Sanitary District of Chicago to reduce the amount of water taken from Lake Michigan for the drainage canal (which handles the sewage of Chicago) has caused the trustees of the District to make an offer to the federal government which it is hoped, and expected, will do away with the diversion and lake levels controversy which has hung over the sanitary district for years.

At a meeting of the trustees of the district on January 5, an ordinance was adopted which binds the district to pay the United States $475,000 and such additional money as may be necessary to construct submerged weirs in the St. Clair and Niagara rivers for the purpose of reducing the flow of water from Lakes Erie, Michigan and Huron. Such weirs, it is estimated by government engineers, would in a few years bring the level of the water in the Great Lakes up to what navigation interests maintain it should be.

Injunction Case Brought

The government has brought injunction proceedings against the sanitary district to restrict the amount of water allowed to flow through the canal and a decision is expected at any time, the cases having been tried before Judge Landis several years ago. If the decision is adverse to the contention of the sanitary district that it has the right to draw 520,000 cu. ft. of water a minute from Lake Michigan the situation would be extremely serious, if not dangerous. The government contends that only 250,000 cu. ft. a minute should be drawn. Limited to that amount only, the sanitary district would have to construct supplemental works for disposing of Chicago's sewage.

The present proposal of the sanitary district is to follow the recommendations of a special board of engineers appointed by the secretary of war in 1910. There is no trouble about Lake Ontario, the Canadian government having closed the Gut channel of the Galops rapids, which has raised the level of the lake to an amount nearly equal to the computed lowering of the lake by the diversion of water at Chicago.

To Build Three Great Submerged Weirs

To compensate for the loss of water in Lake Erie, it is proposed to construct three submerged weirs in Niagara river in the vicinity of Squaw Island, which would average about 4.2 ft. in height and would contain about 15,000 cu. yds. of masonry. The estimated cost is $150,000.

To raise the levels of Lakes Michigan and Huron submerged weirs would be constructed in St. Clair river covering three miles of river below the mouth of Block river, at Port Huron. The weirs would have a height of from 5 to 6 ft. above the river bed, and contain about 65,000 cu. yds. of material, the estimated cost being $325,000. It is computed that these weirs will increase the velocity of the water only slightly. On the other hand, above the mouth of the Black river the river slopes, and velocities which are now excessive will be diminished, and it is asserted navigation would be considerably benefited.

The engineers reported that the Chicago diversion of water had no effect on Lake Superior.

Attorney Gives an Opinion

E. D. Adcock, attorney for the sanitary district, has given the trustees an opinion that the ordinance passed meets all recommendations made by the federal engineers, and will settle a controversy that might result disastrously for Chicago. In his conclusions Mr. Adcock says:

"In view of all the facts and circumstances, it would seem that the payment of the comparatively small sum of $475,000 to settle this whole controversy and relieve the dis-

trict from the possibility of its being curtailed in the amount of water withdrawn is reasonable, and is the only proper and wise course to pursue if the United States will agree."

Having passed the ordinance, the next move of the sanitary district trustees will be to interest the Cook county delegation in congress and have the matter brought before the war department in a regular way. It is not proposed that the district shall construct the weirs, the proposal being that the money be paid to the secretary of war or any designated official, the government to put in the masonry.

A Definite Legislative Policy to Develop the Nation's Water Power

Early in January President Wilson laid before a conference of house leaders the draft of a bill designed to establish a definite legislative policy to develop the nation's water power, 35,000,000 horse power of which is estimated by government engineers to be wasted annually. The conferees adopted a plan to create a special committee of the house to take over all jurisdiction of water power problems and to pass the president's bill promptly.

The new measure was drawn by the interior, war, and agricultural departments. It follows closely the provisions of the Ferris bill, which has twice passed the house, but failed in the senate.

Provides for Long Lease

The bill provides for a commission to be composed of the secretaries of war, interior, and agriculture. It proposes to lease the water power privileges on public lands, Indian lands, national forests, and in navigable streams for not exceeding fifty years, when the project may be taken over by the United States, again leased to the original lessee, or leased to a new lessee.

All property owned and held by the licensee at the expiration of the lease, valuable and serviceable in the development or distribution of power, together with any locks or other aids to navigation constructed by the lessee, may be taken over by the government upon the payment of the fair value, not to exceed the actual cost of the property taken, plus such reasonable damages as may be caused by the separation of the property from valuable property not taken.

Where Money Will Go

Fifty per cent. of the proceeds from national forests shall be expended in construction of roads in those forests; 50 per cent. of the receipts from public lands are to be placed in the reclamation fund; 50 per cent. of the receipts from navigable streams are to be expended in the maintenance and operation of dams and other navigation structures of the United States, and all proceeds from Indian reservation shall be placed to the credit of the Indians.

The president asked that the house rules committee report to the house a rule creating a special committee on water power, with a view to supplying its membership from the regular committees now claiming jurisdiction. It was then suggested the committee be created by a special rule, each of the regular committee members to be taken from their personnel and the speaker appointing them on the new body. This plan was virtually agreed upon.

Personal Items

A. Lincoln Golinkin is now engineer inspector of construction with the Milwaukee Sewerage Commission. He is a graduate of the University of Illinois, class of 1917, and has the degree of B. S. in Municipal and Sanitary Engineering. He was formerly field engineer, commercial department, Chicago Telephone Co.

John Hayes Smith, consulting engineer of Milwaukee, has closed his office to accept a position as assistant engineer to the Public Service Commission of Pennsylvania. Mr. Smith is a graduate of Cornell University who associated himself with the Westinghouse Electric & Manufacturing Company shortly after graduation, remaining in their employ about six years. He is best known as the first manager of the Electric Journal, Pittsburgh. Resigning this position, he became editor of the Electrical Age, New York, for four years. Since that time Mr. Smith has been in Milwaukee. For two years he was with the Milwaukee Electric Railway & Light Company, resigning as commercial engineer to take up consulting work. For the last four years he has been actively identified with much important work in Milwaukee, as well as engaged in rate and valuation work in other states.

H. R. Campbell, on January 1, resigned his position as statistician of the Pennsylvania State Highway Department, because of ill health. He came from Washington, Pa., and was appointed statistician on April 2, 1917, by F. B. Black, former state highway commissioner, to fill the vacancy caused by the resignation of W. R. D. Hall. For a number of years Mr. Campbell was connected with the county commissioners' office, at Washington, Pennsylvania.

William D. Uhler, chief engineer of the Pennsylvania State Highway Department, has been commissioned a major in the Ordnance Reserve of the United States Army. As provided for in the act approved June 7, 1917, Mr. Uhler has requested leave of absence from his duties, which request has been granted by Governor Martin G. Braumbaugh. It is Mr. Uhler's intention, as far as possible, to keep in touch with the work of the State Highway Department. He is considered one of the best road engineers in the United States, was appointed chief engineer of the Pennsylvania State Highway Department on April 7, 1915, to fill the vacancy caused by the resignation of Samuel D. Foster. He was born in Nazareth, Pennsylvania, Nov. 8, 1872. From 1890 to 1895 he was connected with the engineering department of the Lehigh Valley Railroad, leaving there to enter the employ of the Queen Ann's Railroad, where he remained for eight years in various capacities from assistant engineer to general manager and chief engineer. In 1904 Mr. Uhler became county roads engineer of Caroline county, Maryland, serving four years, after which he was appointed to be engineer in charge of maintenance of the Maryland State Roads Commission. He resigned this position in 1912 to become principal assistant engineer of the Bureau of Highways in the city of Philadelphia. It was while serving in this capacity that he was selected by Governor Brumbaugh to become chief engineer of the State Highway Department. Mr. Uhler is a member of the American Society of Civil Engineers, the American Road Builders' Association, the Engineers' Club of Philadelphia, the Engineers' Club of Baltimore, the Engineers' Society of Harrisburg, the American Society for Testing Materials, the American Society of Municipal Improvements and the American Concrete Institute. At its recent meeting in Richmond, Virginia, Mr. Uhler was elected president of the American Association of State Highway Officials.

Arthur Groesbeck, for the past 3½ years superintendent of the water and electric department of McPherson, Kans., has resigned that position and accepted a position with The Riverside Light & Power Co. of Abilene, Kans., as efficiency engineer of the different generating stations. He is a graduate of the University of Kansas, class of 1909. He was formerly chief engineer, Cordova Power Co., Cordova, Alaska, and later superintendent of the water and light department at Stafford, Kans. He assumed his duties at Abilene on January 1.

EDITORIALS

Speed Up National Road Plans

The policy of the federal government is favorable to the construction of essential military and market highways this year, but the plan, the all-important plan, has not been formulated. Thus it may be said that with respect to the building of these roads the government has good intentions. Good intentions are necessary, but not sufficient.

A spur to action comes with the thought that the federal government has favored other measures which it was long in making effective. Though indorsing military preparedness, our federal officials allowed this nation to drift stern foremost into the war; though attempting to arm our troops, there was, and still is, deadly delay in selection and production; though favoring merchant ship construction, choice of type and haggling over details were permitted to delay the shipbuilding program, so that now, almost a year after we went to war, we are nearly ready to utilize the services of volunteer ship builders.

Since war was declared there has been a lack of coordination of effort. Investigations and immature plans have overlapped, become entangled, retarded progress. In numerous instances too many different departments, bureaus, boards, councils, committees, etc., have taken up the same problems and have expended their great energies and precious months in attempting to agree on working plans. The same tendency will endanger the road program unless an informed public opinion demands the speedy formulation and execution of a working plan.

The policy of the federal government, as it relates to highway construction, is rational. In line with a request made by Secretary McAdoo, Secretary Houston, of the Department of Agriculture, which includes the office of public roads, has determined that so far as is practicable the federal aid funds shall be applied during the working season of 1918 only to the construction of such roads as are vitally necessary to improve the transportation system of the country, or to make feasible an increased output of important agricultural products. No fault is found in this general statement of policy.

Now, how is it proposed to apply this policy through a working plan? The first step was the issuing of an order by the Director of the Office of Public Roads and Rural Engineering to district engineers that they take up with the state highway departments in their districts the question of formulating a program for the expenditure of all such funds as are available for the working season of 1918 and such additional period as may be required. It was stipulated that all projects, whether approved or pending, and any additional projects desired by the state, should be included. State highway departments were requested to conform as nearly as possible to the announced federal policy. A supply of schedule forms indicating the information desired was furnished for the use of the highway departments in preparing their program. The Director stated that this information should be had at the earliest possible moment.

That order was issued on January 11. On February 6, almost a month later, the Director stated that "up to this time only a very few of the states have submitted their schedules." The state highway departments cannot escape criticism for this delay. The Director said moment, not month! If even the newest of the state highway departments cannot pass on this matter in a month, what sort of delay shall we expect when the state reports reach Washington and the problem of connecting highways for interstate traffic is taken up? The state departments should be galvanized into greater activity. It is true that the schedules sent out from Washington call for a description of each road, the character, quantity and rail haul of the materials to be used, the probable cost, the amount of federal funds desired, the specific purpose of the improvement and its bearing upon the war situation. If taken too literally that is indeed a large and formidable order, but this is no time for cheese paring and hair splitting in making cost and other estimates. A great emergency is upon us. We haven't all summer to figure on these roads; we must build them! The reports, complete as to broad essentials and as complete as to details as practicable, should be returned to Washington now.

When the state reports are returned to the Office of Public Roads they should be connected up and correlated in the briefest possible time and a comprehensive national highway construction plan formulated. This should be left to the Office of Public Roads, and all other government agencies should keep their hands off the planning. This includes Congress, with its Chamthe actual planning. This includes Congress, with its Chamberlain comprehensive military highways bill, which directs the Chief Engineer of the Department of War to prepare the plans. Since the Department of Agriculture is working on the plans, to have the Department of War take up the same problem would merely make for delay.

When the plans are completed, which should be by April 1 at the latest, the next move must come from Mr. McAdoo, Secretary of the Treasury and Director General of Railroads. In the first capacity he should see that federal aid funds are released for use on the construction of designated highways and that the Federal Reserve Banks shall specify highway construction as a war essential, thus lifting the ban that has rested on the sale of road bonds. This will enable state and county authorities to raise funds to match the federal funds dollar for dollar, and also to construct other highways held essential, though not granted federal aid. In his capacity as Director General of Railroads he must see to it that priority orders and embargoes do not prohibit the transportation by rail of road-making materials and machinery. This will put the actual construction up to local authorities, who can be depended upon to push it.

The delay of the states in reporting back their road plans to Washington is regrettable, but not fatal. A prolonged delay in Washington in considering these plans, and in removing restraints to their execution, will be fatal, absolutely so, to the construction of essential military and market roads this year. Such a delay the public must not tolerate.

City Engineer, Superintendent of Water Works and Sewers

Under the eye-arresting caption, "How a Deficit of $2,000 Was Changed to a Surplus of $27,000 in One Year at the Waltham Water Works," an article is published in this issue that merits the most careful reading. The article was written by a man whose official title is: City Engineer, Superintendent of Water Works and Sewers. That there is a direct connection between the fact expressed in the caption of the article and the duties of the author, as expressed by his title, we are firmly convinced. His engineering training and experience, coupled with his intimate and expert knowledge of the city engineering department and the local sewerage system, enabled him to take hold of the management of the local water works and in one short year convert an annual deficit of $2,000 into a surplus of $27,000. Just how this result was accomplished by the introduction of business-like methods, most of which are of universal application, is related.

In the average city of ten thousand inhabitants and over there is a city engineer, a superintendent of water works and a superintendent of sewers. The superintendent of sewers is also in many cases superintendent of streets, though there are many cities where there is a superintendent of streets to complete the squaring of the local engineering circle. This arrangement reminds us of nothing so much as the familiar sight of four churches, of different denominations, at the four corners of the public square. In each of these churches the Word is expounded by an estimable gentleman who, as a preacher, is of the fourth class or lower. What a melancholy thing it is that the four congregations do not unite under one roof, and, by pooling their finances, provide enough in the form of a salary to attract and hold a first-class preacher! This would not only strengthen the remaining church, but would, as an auxiliary benefit, release the other three preachers to the immediately productive task of plowing corn.

Exact parallels are seldom encountered except on the mathematical reservation, but the parallel here indicated is close if not exact. The consolidation of the four local engineering functions under a single competent and well-paid head is quite as desirable as the ecclesiastical consolidation suggested and is free from the sentimental and transcendental objections which adhere to the latter.

The greatest work remaining in the water works field is the general introduction of efficient and economical operating methods—to no better task can the great water works associations address themselves. If these associations would advocate and work, through suitable standing committees and appropriate publicity methods, for the consolidation of the city engineering and water works departments under the management of an engineer, this desirable end would soon be realized in very many localities, and the bringing under the same head of the sewer and street departments would naturally follow. That there are many competent water superintendents now is not denied; these men have nothing to fear from the new alignment suggested, as they are in charge of departments requiring a competent head, whether they be directly responsible to a board of water commissioners, a city council, or to the head of the city's engineering bureau. On the other hand there are many superintendents who could be removed in the consolidation process without permanent or substantial loss to themselves and to the great advantage of their cities.

Workers for the Shipyards

The war will be won or lost in the American shipyards. At this time the paramount need of America and our allies is for workers in these shipyards; it is vital and urgent. Edward N. Hurley, chairman of the United States Shipping Board and president of the Emergency Fleet Corporation, is calling for 250,000 men, skilled mechanics and laborers, to volunteer their services to help the men now engaged in building merchant shipping. It is urged that men who desire so to volunteer go at once to the nearest enrollment agent of the United States Public Service Reserve of the Labor Department, or to the local enrollment agent of his State Council of Defense, and register themselves as willing to work in the shipyards if needed; then to retain their present positions until called individually.

How imperative is the need for men may be concluded by any person who will but reflect that last year Great Britain produced only 1,163,474 tons of shipping, and the United States but 901,223 tons, making a total new tonnage of 2,064,697, while sinkings by submarines during the same period are estimated at 6,000,000 tons. That way lies disaster. Men must come forward to man the great American yards now nearing completion; engineers and contractors must use their influence to that end. Contractors should note that laborers of all classes are wanted—men whose places can be taken by labor-saving machinery on construction, and should urge them to volunteer.

Original Matter

The discriminating reader undoubtedly has noticed the heavy preponderance of original matter in the reading pages of this magazine. About 90 per cent. of all articles published in MUNICIPAL ENGINEERING during the past six months were written for our exclusive use. The remaining portion of the editorial matter has been made up of articles of varied origin which we have felt should be published in our readers' interest, though not written primarily for that purpose. It is doubtful if any engineering periodical has exceeded, if indeed it has equaled, this sustained record of freshness and originality in reading matter.

The significance of this record should be noted. The reader will not find in the pages of MUNICIPAL ENGINEERING a plethora of papers prepared for presentation before professional societies. The scheme of monthly publication lends itself readily to the exclusion of matter which the journal of more frequent publication commonly uses in its craving for copy. Neither will our readers find windy dissertations on matters of but momentary interest to a minority. Underdone abstracts of voluminous city reports are also taboo. In general, the editor hopes to enjoy the esteem of his readers for what is omitted quite as much as for what is admitted.

In each issue experts exchange ideas with each other and with members of the profession generally. Thus, in the December issue announcement was made of special contributions promised for 1918. These articles are all by recognized authorities and are a leading feature of current issues. The January issue, for example, contained articles by Messrs. Howard, Brossmann, Thomas, Pearse, Ledoux and McDonnell. The February issue contained the special contributions of Messrs. Knowles, Alvord, Weston, Collins, Tribus and Shields.

There are more of these special articles in the March issue, as well as many other articles of equal merit, and there will be others in every issue.

SEWER DESIGN AND CONSTRUCTION

Simple and Inexpensive Method of Lifting Sewage Sludge to Sludge Beds or Outfall Sewer

By Alexander Potter, Consulting Engineer, 50 Church Street, New York, N. Y.

It is often impossible to construct a sewage settling tank at such an elevation above the ground that the head of the liquid in the tank itself is sufficient to force the sludge on to the sludge drying beds by gravity.

Where the sludge can not be discharged upon the sludge drying beds by gravity, pumping, of course, must be resorted to, and especially in smaller installations it is very difficult to secure satisfactory results, because either the pump loses its priming or some foreign substance clogs the lower end of the suction pipe, or perhaps in most cases a combination of both these troubles occurs, which makes pumping unsatisfactory in many cases.

Vacuum Pump and Receptacle

To overcome the difficulty thus encountered in some forms of settling basins, both deep and shallow, the writer devised a simple method of lifting the sludge above the surface of the water in the settling tank into a receptacle from which it could flow by gravity on to sludge drying beds or into the outlet of the treated sewage, as the case might be.

The figure shows such an installation and an examination of it discloses that the apparatus consists of a riser pipe extending from the bottom of the sludge chamber and discharging into the top of a steel tank 4 ft. in diameter and 4 ft. deep, with a tapered bottom, erected above the surface of the sewage in the settling basin. From the tapering bottom of this tank a pipe is led either to the sludge beds or to the outlet end of the settling tanks. The steel tank thus described is gated on the inlet and outlet ends with an air tight valve. There is located in the building near the steel tank a small rotary vacuum pump direct connected with an electric motor, if electric current is available, or to a small gas or gasoline engine, if electric current is not readily procurable.

The vacuum pump used in several recent installations was a No. 2 Rotary furnished by the Beach-Russ Company of New York. This pump is of the rotary sliding vane type, thus obviating the usual resultant troubles common to the reciprocating type of valve pump. A cylindrical drum is eccentrically placed in a steel elliptical cylinder, the drum consisting of four sliding plates. As each plate passes the inlet port it takes in and traps the air, carrying it around to the point where the drum and cylinder come into contact and presses the air out at that point. There is no appreciable wear due to operation, and the pump will stand considerable abuse.

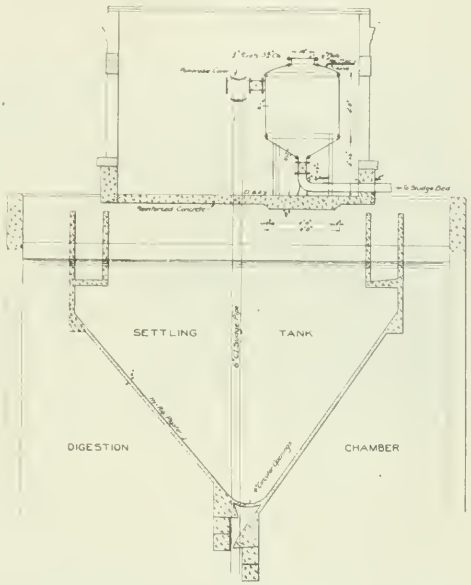
Operation of Sludge Lifting Device

To operate the sludge lifting device, the valves are closed on the inlet and outlet pipe and the air exhausted by means of the vacuum pump. A vacuum of 28 ins. is readily procurable, provided the inlet and outlet valves are tight. In this connection it might be stated that while it is easy to procure valves which are tight against 300 lbs. of water pressure, many of these valves are not air tight against much lighter pressures.

When the air has been exhausted, which will probably take ten minutes, the inlet valve is opened slowly at first and the sludge rushes up from the bottom of the sludge chamber until the air pressure within and without the tank is balanced. The outlet pipe can then be opened and the tank emptied.

Removing Obstructions

As above stated, the mouth of the pipe extending down into the sludge is often obstructed, sometimes totally, by a piece of water soaked board, a brick or some other foreign substance which normally should not enter the tank, but which causes considerable inconvenience and trouble when a centrifugal pump is being used to lift the sludge. When such a condition occurs with the apparatus herein described the simple manipulation of valves changes the vacuum pump to an air compressor and the steel tank becomes an air receiver.



SIMPLE APPARATUS FOR LIFTING SEWAGE SLUDGE FROM SETTLING TANKS.

When the inlet valve of the tank is opened the compressed air rushes down through the inlet pipe and readily dislodges any obstruction which may be blocking its mouth.

The cost of installing the pump motor and steel receiver to care for the sludge of a city up to 10,000 people is less than $1,000.

Latest Developments in Poured Joints for Vitrified Pipe Sewers

By H. P. Boynton, Engineer's Building, Cleveland, Ohio

Developments of the past few months in sewerage practice make it virtually certain that the process of troweling sewer pipe joints by hand out of Portland cement mortar will be replaced by poured joints within a comparatively brief period. The Sewer Pipe Manufacturers' association, a body organized for publicity and research in the sanitary field, has stood sponsor for experiments directed toward this outcome and its field commissioner, John L. Rice, expresses himself as satisfied with the outcome.

Disadvantages of Troweled Joint

The association takes the view that their material has suffered too long from unmerited criticism, growing out of instances where the methods of joining have been defective. Against the hand troweled joint, it is recognized that a trench is an awkward place for careful workmanship and that, where success depends upon the skill of a manual operation, there would be a considerable number of faulty joints due alone to the difficulties under which the sewer worker labors.

But the difficulty with this form of joint has at least two other sources:

1. Cement and sand mixed in a comparatively stiff consistency do not result in an impervious compound, when set, as is the case with a grout of the same composition mixed thin enough to pour.

2. Two-thirds of the trouble with hand troweled joints results from manipulating the pipe in making the ensuing joints. Even if the troweled joint is perfect, when made, it is shortly cracked by handling the other end of the pipe.

The Remedy for Poor Joints

Looking for a thorough going remedy, the association saw the comparative futility of mere emphasis on careful workmanship. The problem was to insure the penetration of the joint material into the recesses of the pipe bell and to prevent manipulation of the pipe after the material was in place and before it was set.

Obviously gravity was the most reliable force in insuring penetration. To prevent disturbance of the joint, the one requisite was to provide forms which could be applied to all of the joints of a pipe line in sequence and then permit them to be poured in sequence, leaving the form in place until the initial set is complete.

The "Flexform" Joint Form

In working out the solution along these lines, the greatest assistance was realized from De Witt H. Wyatt, a young engineer living in Columbus, Ohio, who had begun his experiments independently, but continued them in co-operation with Commissioner Rice. He invented a joint form, which he has named the Flexform, consisting of a series of overlapping, scale-like sections of sheet metal, clamped around the pipe in such a manner as to afford just room for the joint material. There is a hopper or funnel at the top through which the material is poured. The scale structure permitted a certain amount of leakage, not enough to result in serious waste, but enough to safeguard against air pockets in the lower part of the bell.

Joints Caulked with Oakum

In earlier forms of the device the sheet metal sections were strung on two steel cables of small diameter, but the newer ones are joined with hooks, so that a greater or lesser number of scales can be used in a single form, varying with the diameter of the pipe. Before applying the forms, the bell is caulked with just enough oakum to prevent the joint material from reaching the interior of the pipe.

Joint Material

For joint material the association has expressed approval both of cement grout and certain bituminous compounds of the character of G. K. compound, produced by the Atlas Company. The latter is especially recommended where rapid setting is a necessity and where, for any reason, such as trenching through filled earth, a certain amount of elasticity in the line makes a desirable safeguard against breaking strains upon the pipe line.

As the sanitary regulations of most cities direct that house drain trenches shall be left open for 24 hours after construction for purposes of official testing, the grout joint has time to set before the trench can be closed. Tests conducted under these conditions have proved uniformly that the poured grout joint is thoroughly impervious as well as economical of material, rapid and convenient of construction.

The need of removing the form is recognized, however, as a slight handicap in operations where it is desired to close the trench promptly, as in machine excavation of municipal sewers. Ensuing experiments have been directed toward developing a joint form cheap enough to be left around the joint and buried in the ground. Announcement of success in this quest is confidently anticipated.

MODERN METHOD OF POURING JOINTS IN PIPE SEWER CONSTRUCTION.
Left to Right: Applying the Form in the Trench—Pouring a Joint with Cement Grout—A Neat, Economical and Impervious Joint.

Construction Plant and Methods Employed on Recent Important Sewerage Work in Illinois

Among the most important pieces of construction work on sewerage projects carried on in Illinois during 1917 were the large intercepting sewers built by the Sanitary District of Chicago in the Calumet region and in the city of Evanston; the Argyle Street system built by the City of Chicago; the system built at the Government Cantonment at Camp Grant, near Rockford, and the Sewage Disposal Plant at the U. S. Naval Training Station at Great Lakes. The data here given on these construction jobs are from the report of the subcommittee on construction of sewerage works of the Illinois Society of Engineers, composed of H. R. Abbott, Chicago, chairman; Herbert E. Hudson, Chicago, and Edwin Main, Rockford. We are indebted to Mr. Abbott for the views shown.

Notable Construction Work by the Sanitary District of Chicago

Some interesting construction features may be briefly noted relative to the Sanitary District work. These sewers range in size from 10 to 17½ ft., horseshoe shape, and are built of concrete. In some localities they traverse soft yielding ground,

in which case the section is reinforced. The drag line excavating machine is being successfully used on several miles of the Calumet work, which passes, in some cases, through built up streets. This machine is used in conjunction with a steam shovel. The shovel is placed in the cut and takes out approximately the upper half of the total depth. The drag line follows and is also down in the shovel cut and takes out the lower half, cutting the sides of the trench vertical, or nearly so, for this portion. On one contract both of these machines deposit the excavated material direct into standard gage 10-yd. dump cars standing on track parallel with the work. This work is in good hard clay and no difficulty is experienced in holding the sides of the trench with a limited amount of sheeting and bracing. The total depths of these cuts run from 26 to 30 ft. The top portion, or shovel work, is sloped back at about one to one slope.

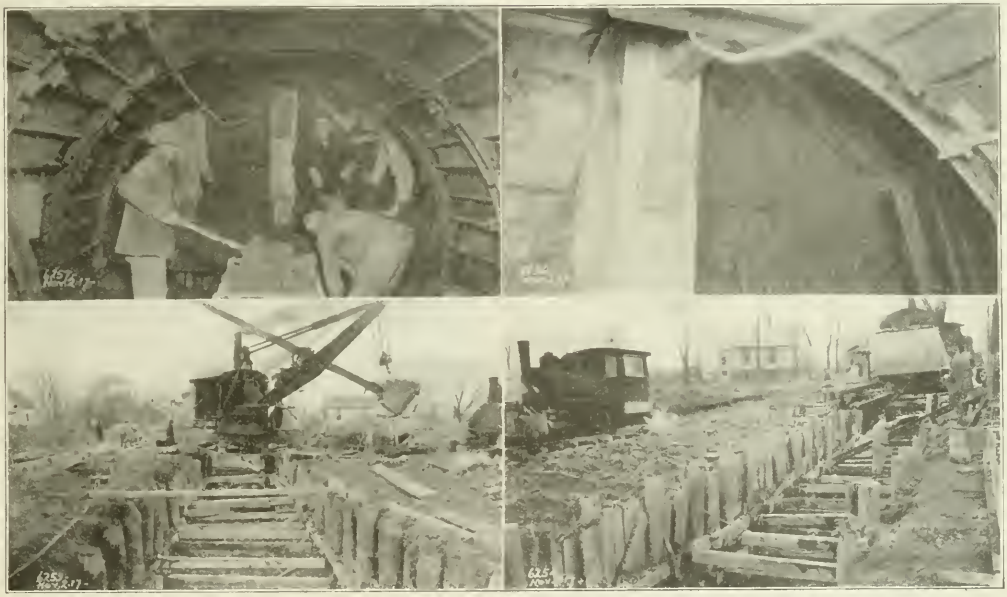
Three contracts on this project are now under way, the contractors being Nash Brothers, Byrne Brothers Dredging and Engineering Company and the T. J. Forschner Contracting Company. The method of excavation is similar with all. Two sections are completed, the entire length of the interceptor being about nine miles, extending from South Chicago to Blue Island and discharging into the Calumet Sag Canal.

Open Cut Abandoned for Tunneling in Soft Ground

Probably the most difficult work during the year by the Sanitary District was the construction of a 10-ft. sewer in West Lake Street, Evanston. The soft, yielding clay could not be held in place by the combined use of 3-in. sheeting, 20 ft. long, driven tight, and 30-ft. piles on 5-ft. centers. Both sheeting and piles were driven ahead of the steam shovel, which was mounted on timbers spanning the trench. This shovel later excavated between the sheeting and as the material was taken out and before the cross bracing could be placed, the movement of the clay would occur, pushing the piles and sheeting inward for the lower half of the 20-ft. cut to such an extent that large portions of the piles and sheeting had to be cut out and additional excavation made. Several schemes were tried out—using two steam shovels working tandem and using one shovel on the top lift and orange peel derrick on the lower lift. None was successful and the method of work was then changed to tunnel, where fair progress is being made, although continuous timbering is necessary. No air pressure is being used. Previously, on the same contract, some 8,000 ft. of sewers of 6, 7½ and 10-ft. sizes were built, using air pressure.

Combining Open Cut and Tunnel

Another interesting piece of work on this contract was the building of a 4½-ft. concrete sewer partly beneath and projecting into a 5-ft. brick sewer, the new sewer having a grade in the opposite direction. This work was 4,000 ft. in length and was built partly in tunnel, tearing out the lower half of the brick sewer in stretches of about 50 ft. and underpinning the arch, then building the new sewer by the usual tunnel method. After the completion a void existed between the crowns of a new and old sewer. Holes about 18 ins. in diameter were dug from the street surface, the crown of the old sewer broken through, permitting the spout of the mixer to be lowered and the void filled with grout. These holes were spaced about 50 ft. apart. On the stretch built by the open cut method the old brick sewer was ripped out by the steam shovel as the work progressed. The Evanston contract is being executed by the Nash-Dowdle Company of Chicago and comprises a complete intercepting system 9 miles in length, including all sizes from 9 ins. to 10 ft. All sewage will be discharged into the North Shore Channel of the Sanitary District of Chicago.



CONSTRUCTION VIEWS ON TUNNEL AND OPEN CUT SECTIONS OF 10-FT. SEWER IN LAKE ST., EVANSTON, ILL.
Left to Right: Blaw Steel Forms in Tunnel Section—Segmental Timber Bracing Ahead of Blaw Forms—Steam Shovel Excavating Between Sheeting and Piling—Pouring the Sewer Invert Behind the Steam Shovel.

The Argyle Street Sewers, Chicago

The City of Chicago constructed a total of about 70½ miles of sewers during the year. Of these about 65 miles were tile pipe and the balance of 5½ miles were brick with a small amount of concrete. Two large systems completed this year are worthy of special mention. The Argyle Street (Norwood

Park) System was constructed to drain the northwestern portion of Chicago. Much of the territory included in this drainage district is unsettled and construction was comparatively simple. As the sewer was designed to relieve some existing systems, several interesting features were presented. Brick sewers in sizes ranging from 9 ft. down to 2 ft. were constructed. The total length of sewer was about 14 miles. The ingenious use of wiers in diversion chambers, carries the flow of sewage during periods of little or no rain to the North Shore Channel of the Sanitary District. Provision is made in these chambers so that, during periods of storm or great flow, excess water is discharged into the North Branch of the Chicago River. H. J. McNichols Company were the contractors on this work. Construction covered a period of two years.

The Rockwell Street Sewers, Chicago

The Rockwell Street System was constructed to afford relief to a large area on the west side. It is one of two similar systems designed to afford relief to a large portion of the west side. The other, known as the Albany Avenue System, was constructed some years ago. The complex nature of construction on such a system of sewers, when constructed in a developed portion of a large city is very interesting. No less than 17 public utilities or functions were encountered and the maintenance of service from these is a great problem. Many streets were paved and the removal and replacement of pavements was a large item in the cost. A portion of the Rockwell Street System was constructed in tunnel. The amount of the contract was about $317,000 and construction covered a period of two years. Circular brick sewers in sizes ranging from 10 ft. down to 4½ ft. were built. John W. Farley was the contractor.

Relief Sewer Program Covering 20 Years

The City of Chicago, through its Board of Local Improvements, has announced a program for the construction of relief sewers for that city, covering a period of twenty years. This is in addition to the work contemplated for the natural expansion and growth of the city. Careful studies made of existing systems of sewerage and the development taking place within the city, indicate the general outlines of districts which will need relief. Plans are formulated and details being worked out on a regular schedule. Such a program indicates the earnestness and zeal with which the sewerage situation in a large city is being watched by its engineers.

Rapid Work on Tile Pipe Sewers

The construction of a large amount of 12-in. and 15-in. tile pipe sewers in Chicago has enabled the contractors to develop and standardize their organization for this particular class of work. As an instance of this, it is interesting to note the record made by The Ryan Company on November 20, 1917. In an 8-hour day they excavated trench for, and laid 1,338 ft. of tile pipe sewer of the sizes mentioned. The average cut was slightly in excess of 7 ft. An Austin excavator was used.

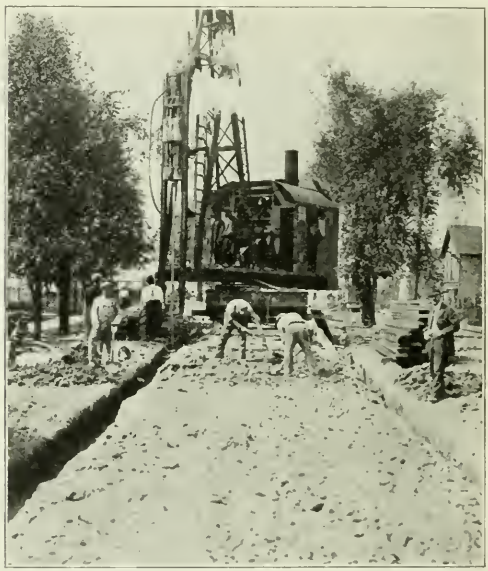
Fast Work at Camp Grant

For rapid construction work the establishment of the U. S. Cantonment at Camp Grant can be cited as an example. On July 1 this site was forest, tilled land and pasture. On October 1 it was a city having hundreds of buildings and possessing water works, sewerage system, heating and lighting plants and miles of paved roads and streets. The sewers are on the separate system plan and are designed for a population of 42,000. Numerous outlets were built, thus avoiding any excessive cuts. These outlets are carried, partly to the Rock River, and partly to the Kishwaukee River, cast iron pipe being used from the last manhole to the thread of the stream. These streams were all ready heavily polluted and no attempt was made to protect them from pollution from the camp. A total of 26.6 miles of vitrified tile pipe, varying in size from 6 to 24 ins., was laid in cuts averaging 4½ ft. The ground was sandy loam and sand and gravel. Work started July 10 and was 90 per cent. completed August 20, the last 10 per cent. being done by Austin machines with a maximum of eight machines on the work, with the following results:

The average daily progress, all machines	545 feet
Best machine average	755 feet
Best day's work, single machine	1,700 feet

U. S. Naval Station Work at Great Lakes

With the large increase in population at the U. S. Naval Station at Great Lakes during the summer of 1917 the authorities decided to build a new sewage disposal plant. This plant, designed for a population of 30,000, is nearly completed and has a nominal capacity of 3,000,000 gals. of sewage per day. It consists of sludge separating tanks followed by aeration, sedimentation, sterilization and filtration.



PILE DRIVER DRIVING SHEETING AND PILES AHEAD OF STEAM SHOVEL ON OPEN CUT SECTION OF 10-FT. SEWER, EVANSTON, ILL.

There are three parallel sets of hopper bottom tanks, each tank being in two compartments, which are separated from each other by a sludge digestion chamber. The tanks are similar to those designed by Alvord and Burdick for the City of Madison, Wis., about four years ago. They are located on top of the bluff and about 50 ft. above the water level of Lake Michigan. The effluent from the tanks passes over a series of aerating steps built into the slope of the bluff and thence through a mechanical filtration plant of the water works type, including a concrete mixing chamber, sedimentation basins and four mechanical filters.

The tanks and aerating steps have been in operation for about three months. The filter plant, together with the mixing chamber and coagulating basins, were placed in operation by the middle of January.

The operation of this plant is producing some very interesting results. During the month of December, owing to the discharge of waste water from the steam heating system, the flow through the separating tanks and digestion chamber was at a temperature of about 90 degrees F. There was little loss in heat during aeration down the steps to the filtration plant. The effect of such a temperature on the effluent should be very

interesting and it is hoped more detailed information can be obtained on this matter later.

This plant, as well as the sewer, water, heating and lighting systems at Camp Grant were designed by Alvord and Burdick, Consulting Engineers, Chicago. John Griffiths and Sons were the contractors for the plant at Great Lakes. All construction in connection with the Cantonment at Camp Grant was performed by Bates and Rogers, contractors, Chicago, working on the "cost plus a per cent. basis."

Cost Keeping

Increasing attention is being given to accurate cost keeping by engineers in charge of work, with a view of arriving at reliable unit costs for the different kinds of work embraced in the contracts.

It is worthy of note that the Sanitary District of Chicago has recently taken steps to establish a Cost Keeping Division, in charge of an Assistant Engineer. The results possible from such a department are only limited by the field covered. As this field is very large with this particular organization, the results are sure to be very valuable. It is to be hoped that this example will be followed by other great construction organizations.

Considerations Affecting the Choice Between the Separate and Combined Sewer Systems

By Paul E. Green, of Marr, Green & Co., Consulting Engineers, 17 N. La Salle St., Chicago.

When the officials of a community have decided that a sewer system is needed and an engineer is engaged for the purpose of designing such a system, the first question which must be settled is the type to be installed. Broadly speaking, there are two types of sewer systems; that is, the separate and combined. The sanitary sewer, which handles interior wastes exclusively, requires that it be supplemented by a system of storm water drains. The combined system is, as the name signifies, one that not only takes care of the interior wastes, but all street and other exterior drainage. The combined sewer must, therefore, take care of from 20 to 50 times as much waste liquid as the sanitary system, and this means that the sewers themselves must be proportionately larger. Storm water drains will be of the same size as the combined sewers if they cover the same territory.

Conditions Governing Selection of Type.

Conditions governing the selection of type of sewer may be grouped generally under the following heads, to-wit: Population—its character and its growth; topography; the character of the soil, that is, whether or not it is underlaid by rock, etc., the disposal of the sewage, and the condition of the streets.

Population

A very important factor in the design of a proper system is the population. If the community is a small one and has not had any appreciable growth for many years, and if its situation is such that it is not likely to increase materially in population, the problem is considerably simplified. Most of the inhabitants will then be property owners. The property will not have been bought as an investment or speculation, and the sewers, if put in, will be largely a convenience and possibly a sanitary necessity. The actual installation of the system will not materially increase the value of the property, and it will be difficult to assess such property a large amount.

Topography

Furthermore, if in this community the topography is such that the natural drainage is good and the people are not much troubled with low swampy spots, the decision will wisely be for a simple sanitary sewer, which may be constructed at a minimum cost. On the other hand, if a community is an industrial one, rather close to a larger city which has a combined system, it is probable that even under extreme circumstances the more expensive combined system would be the one to put in, unless the question of disposal is such a grave one that it would be the governing point.

Abuse of Separate Systems

In cases like the two cited above, the decision is relatively simple. The problem becomes much more complicated when the extremes are not so apparent, and then many other things must be taken into consideration, not the least important of which is human nature. Most State Boards of Health advocate the separate system, but the average person fails to discriminate between them. It will almost invariably be found in a few years after a sanitary system has been installed that not only is roof water being led into the mains, but that even the city authorities are connecting street inlets to it, and when this system has also a disposal plant in connection, the result is frequently disastrous. After every storm, sewage is backing up into the basements of houses, and about this time a demand for a system of storm water drains is voiced. As most of the property owners have a very distinct recollection of what they paid for the sanitary system, and as the assessment for a storm water system is generally considerably heavier, there is liable to be very lively controversies before the question is settled.

Length of Outfall Sewer

Another very important point to be considered is the distance to a proper outlet for the sewage. If it is several thousand feet from the corporate limits to a proper disposal site, the expense of carrying a large sewer such a distance is very material and may be so great as utterly to discourage the city officials. However, as an assessment proposition, it has been found that people as a rule are much more willing to pay an assessment for the combined system of sewers than they are for a sanitary one, even though the assessment for the combined system may be two or three times as great as is required for the alternative.

Where the Choice Is Easy

There is one situation in which it is nearly always advantageous to put in a combined system. This is one in which the entire community is underlaid by rock. It is almost as expensive to excavate narrow rock trenches as the wider trench required for the larger combined sewer. It will be found that the unit price of rock excavation on large sewers is decidedly less than that for small ones.

Proper Financing

Proper financing of such an improvement requires careful study. A great many mistakes have been made in the past in this matter. The first time a system is put in, the easy way is to pay for it by means of a general bond issue. A more equitable method, however, is to put it in by special assessment, which can be done in nearly all of our states, though the laws of some are defective. This is on the theory, of course, that the property that is benefited should pay for the cost of the improvement. A further great advantage is that the city as a whole is always in much better financial condition when improvements are put in under this plan than when they are financed by means of a general bond issue. Once having started to build improvements from these bond issues it is very difficult indeed to change. People that have not as yet had an improvement cannot understand why they should pay their special assessment when other parts of the community have had their sewers put in for them. The result is that the municipality is always in financial trouble, as the bonding power is soon exhausted. Improvements are stopped in a few years and the progress of the community is retarded.

Study the Money Market

In those states which permit a variation in the number of years or installments for paying special assessments it will repay the engineer to study the money market. At times five-year paper is better than ten-year, and then the reverse is true. It will depend on the value of money at the time.

The Proper Installation and Maintenance of Automatic Sewage Siphons and Ejectors

By S. Fischer Miller, President Pacific Flush-Tank Company, Singer Bldg., New York, N. Y.

Apparatus usually receives, at the hands of the designer, considerable thought and study in standard construction and standard uses; also, in special uses a further amount of study is required to adapt standard equipment to the purposes intended. Such study and research varies in direct proportion to the personal equation of the manufacturer. It can be stated, however, as quite a matter of fact, that no apparatus is offered for sale or installation for any unsuitable use, if the manufacturer is fully advised in advance.

It is obvious, therefore, that all parties contemplating the use of automatic equipment, such as sewage disposal apparatus, ejectors, etc., should avail themselves not only of the literature the manufacturer prints, but the personal services of the same manufacturer in an advisory capacity, before such equipment is ordered through the contractor.

Precautions in Design and Installation

In designing plants requiring apparatus, full consideration should be given for growth in volumes of sewage to be handled and the character of the sewage, in order that the apparatus may be adequate in size to perform the duty required, and in many instances, particularly in ejectors, duplicate installations, each equal to the maximum requirement, should be installed.

In installing apparatus of this character the municipalities should employ the manufacturer to exercise a certain amount of supervision, as may be required, to see that the work is performed in such a manner that the apparatus will satisfactorily operate and continue to operate.

The municipalities should require full sets of assembly drawings of all such apparatus, and, before the contractor is discharged and the apparatus accepted, the mechanic to be placed in charge of the plant should be carefully instructed in the use of the apparatus.

Specific Suggestions on Maintenance

In the maintenance of such plants the municipalities are under the disadvantage of frequently changing their employes, and it must be obvious that an unskilled operator may not be able to secure from any apparatus the results obtained by his predecessor, who was able to operate the plant and understood thoroughly the basic principles of the machinery.

A record should be kept at the plant of the performance of the apparatus, the same requiring little or no attention, except possibly after a very heavy storm in plants where the sewer systems tributary are combined and not separate.

All moving parts apparatus requires considerable attention at the place of wear, and non-moving apparatus requires occasional cleaning.

Pits and pockets containing apparatus are likely to sludge up, and should be pumped out and kept clean at the bottom, at comparatively regular intervals.

Plants should be more or less protected from loose leaves, sticks, and rubbish generally, which may be thrown into the pits, and this is accomplished by covers over the apparatus, with open joints for ventilation.

Plants that are exposed to freezing in very cold exposures should be protected during the winter months.

It would be wise for each municipality to employ the original designing engineer to inspect its plant at intervals of, say, once in sixty days for large plants, and possibly once in six months for smaller plants. The expense for such inspection would be well justified, as errors in operation would be corrected and results obtained continuously for which the plant was originally designed.

The manufacturer of the apparatus furnished and installed could properly be employed in the larger plants to make examinations, rather than to permit an unskilled operator to conduct his own experiments, or to alter the apparatus without consulting the manufacturer.

In a general way the simpler the apparatus is, the more readily it is comprehended by the average caretaker, and the more reliable the manufacturer is, the more serviceable the apparatus will be.

Summary

In summarizing, it would appear to be very essential that maximum volumetric conditions be thoroughly taken care of in the original design; that loss of head necessary for successful operation be also thoroughly understood and arranged for; and, further, that the apparatus itself be observed at regular intervals, and all chambers containing the same be protected from rubbish of all sorts, and frost, and kept clean, so that the equipment may not fail.

All hydraulic apparatus requires to be installed in watertight compartments, and the outfalls from the plant must be able to take off the sewage at the maximum rate, and the outlets remain free at every point.

Municipalities owning sewage disposal plants should not hesitate to communicate with the manufacturers of all such apparatus, providing themselves with proper assembly drawings and literature pertaining to the special apparatus furnished, and its engineering department should be familiar with these also.

Water Works Design and Construction

The Range of Results Obtainable in the Use of Concrete in Water Tank Construction

By C. C. Whitaker, Consulting Engineer, Forsythe Bldg., Atlanta, Ga.

The application of reinforced concrete to artistic architectural work is not new; in fact, the history of Ferro or reinforced concrete seems to indicate that its first use was the construction of an ornamental flower pot or urn, which, when further considered, amounted to simply a small tank.

Possibilities of Concrete in Tank Construction

It is the purpose of this article to show from the standpoint of tank construction what has been accomplished in this type of structure by the utilization of concrete, and the vast possibilities that exist in this material when rightly used.

From time to time very interesting accounts of reservoir or tank construction in reinforced concrete have appeared in a great number of publications, and different parts of the work have been featured to a more or less extent.

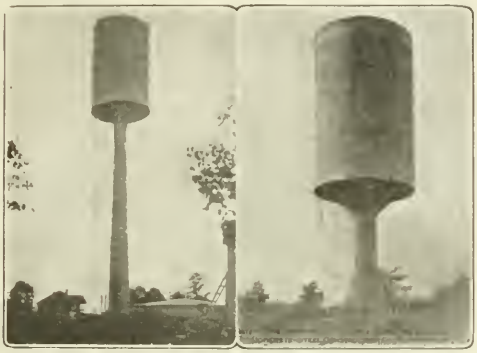
The actual designing methods used in all work of this kind vary, though in general they amount to simply the utilization of long-accepted theories applied to a new condition. It is not the purpose of this article to deal to any great extent with the technical features of tank or standpipe design, or methods of construction.

The architectural details that can be accomplished are

so vast in their number and types that it is simply a case of the ingenuity or artistic talent of the designer.

Common Types

There are very few that have not seen the ordinary, every-day standpipe and tank tower of concrete holding either a tank of concrete or some other type of material. Some years ago, and not so many at that, a structure of this kind was looked upon as a novelty. Those of us, however, that were keeping abreast of the times not only saw the stability and far-reaching effect of concrete for uses of this kind, but realized without question that for this type of work concrete had come to stay, and still further, that its possibilities were unlimited.



VIEW OF REINFORCED CONCRETE WATER TANKS OF GOBLET TYPE AT BAY MINETTE AND NORTHPORT, ALA.

An ordinary square leg or otherwise straight-leg tower or bent construction is one that needs no comment. We, therefore, pass this type of construction for one that is going to seem like a very daring design.

Novel Tanks at Bay Minette and Northport, Ala.

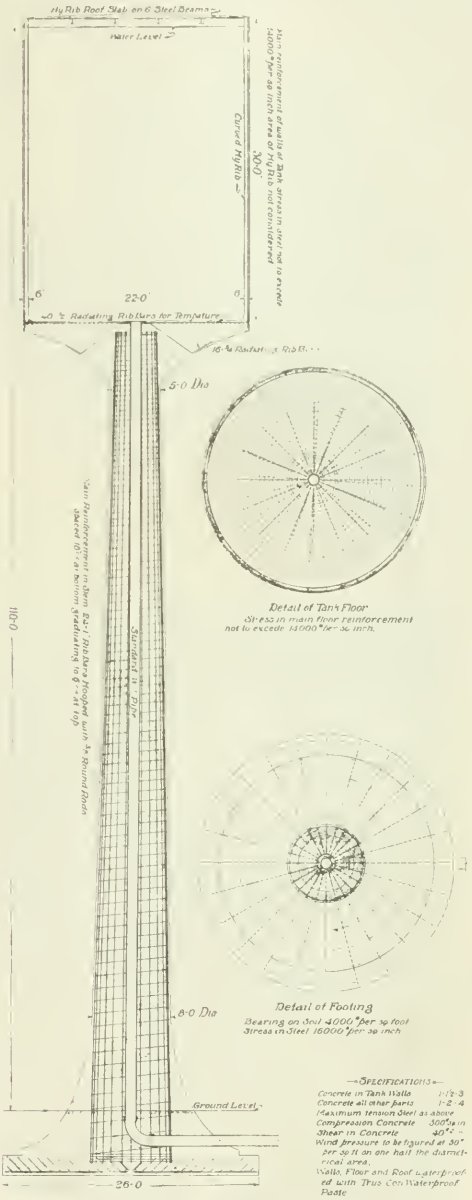
By referring to the cuts herewith of tanks at Bay Minette and Northport, Ala., and the details of the former, it will be noted that by enlarging on an ancient kind of water receptacle a very novel as well as stable and pleasing type of reservoir design has been accomplished. These tanks are known as goblet tanks, owing to their likeness to the drinking vessel of the same name. By referring to the reproduction of details it will be very easily seen that what at the first glance appears to be a very daring design is far from such and by the use of standard practice and accepted theory has reduced itself down to simplicity itself.

The tank at Bay Minette is 80 ft. from ground to tank bottom, and that at Northport 30 ft. from ground to tank. Both tanks are 30 ft. in depth and of 80,000 gals. capacity. The overall heights are 110 ft. and 60 ft., respectively.

Use of Hy-Rib in Bay Minette and Northport Tanks

The barrel of the Bay Minette (Ala.) tank was formed by the use of two lines of curved Hy-Rib (one inside and one outside) the Hy-Rib acting as a permanent form and at the same time a part of the reinforcement. The inner line of barrel of curved Hy-Rib was waterproofed cement stucco, using the integral method, with Trus-Con Waterproofing Paste. This was allowed to set up, thereby performing two duties in the construction, one being the waterproofing of the inner face and the other the permanent closed form. When it is taken into consideration that this tank stands 110 ft. above the ground the advisability of this method of forming can very easily be appreciated. When water was turned into the tanks at full pressure there were no signs of leakage.

In the forming of the barrel of the Northport (Ala.) tank, which is considerably lower than the Bay Minette tank, it was found advisable to use only the curved Hy-Rib for the


Hy-Rib Roof Slab on 6 Steel Beams
Water Level
Curved Hy-Rib
30-0
22-0
6
6
Radiating Ribbing for Temperature
5-0 Dia
Detail of Tank Floor
Stress in main floor reinforcement not to exceed 14000 lbs. per sq. inch.
110-0
Standard Pipe
8-0 Dia
Detail of Footing
Bearing on Soil 4000 lbs. per sq. foot
Stress in Steel 16000 lbs. per sq. inch
Ground Level
26-0
Specifications
Concrete in Tank Walls 1-2-3
Concrete all other parts 1-2-4
Maximum tension Steel as above
Compression Concrete 300 lbs. in
Shear in Concrete 40 lbs.
Wind pressure to be figured at 30 lbs. per sq. ft. on one half the diametrical area.
Walls, Floor and Roof waterproofed with Trus Con Waterproof Paste

DETAILS OF DESIGN OF REINFORCED CONCRETE TANK OF GOBLET TYPE AT BAY MINETTE, ALA.

inner form, which was treated the same way as the Bay Minette tank, and to use metal forms for the outside.

Severe Test of Stability of Bay Minette Tank

About the middle of June, 1916, one of the most severe storms that has ever visited the Gulf Coast section of the

country swept over Bay Minette, Mobile and Northport. During this storm, according to the Weather Bureau reports, the wind reached a velocity of more than 80 miles an hour.

The Bay Minette tank was, comparatively speaking, green as it had then only been completed a short time. In the town proper of Bay Minette a great many residences and other buildings were unroofed. Quite a number of structures were completely demolished and a vast amount of other damage done by the wind. The correctness of the assumptions of this design has without doubt been proven as both of these tanks are now standing and show no signs of any weakness due to the tremendous pressure put upon them.

As a further demonstration of the stability of this type of structural design; these tanks were in no way guyed or stayed to the ground and relied entirely on the stem for the transmission of the pressure into the footings, which in turn must have been correctly designed against overturning.

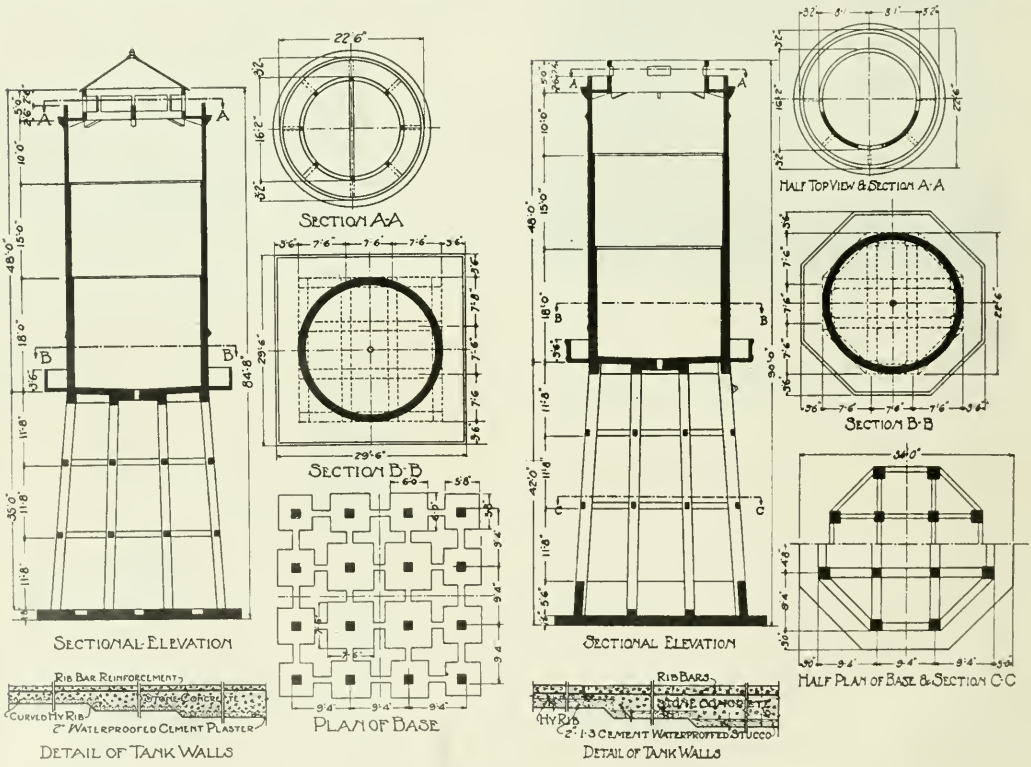
Ala., Mr. L. H. White, President and Chief Engineer. The tanks shown were constructed by them.

Architectural Possibilities in Use of Concrete

There is no reason why, with the architectural possibilities in concrete work, that tanks or water supply systems in large and beautiful estates should not be made one of the most beautiful parts of the general scheme of improvement, rather than an eyesore; as has been the case for a number of years and will almost always be the case in the old, antiquated type of either stave tanks on pipe bents or steel tanks on the same or kindred type of towers.

The Alton Beach Tank at Miami, Fla.

One of the first sections to realize the necessity for departing from the old type of structure was Miami, Fla., on the Carl Fisher Estate improvements, Alton Beach. In this



REINFORCED CONCRETE WATER TANKS NOS. 1 AND 2 AT ALTON BEACH, MIAMI, FLORIDA. EACH TANK OF 100,000 GALS. CAPACITY. KAHN SYSTEM OF REINFORCEMENT USED.

As a matter of interest, it may be well to mention that both of these tanks were awarded in direct competition against steel tanks on steel towers and that in both cases there was a saving in first cost realized.

There is nothing architecturally beautiful about these structures, but the oddity of the design lends interest to the general condition and makes possible a tremendous saving in room space, thereby recommending the general adoption of this type of structure for commercial or manufacturing water supplies.

The patents of the design for these goblet tanks are owned by the Concrete Steel Construction Company of Birmingham,

development are located private residences and home estates in which the general type of structure has run in actual cost of production from $20,000 to untold thousands, and no money, in a great many cases, has been spared to make them not only most modern, but as beautiful architecturally as possible.

The water supply system, which had been taken care of largely by small pumping stations and private wells, resolved itself down, from the fire protection standpoint if nothing else, to a large central supply. As the general topographical layout of the ground is perfectly flat, having an altitude of only about 9 to 12 feet above high water, it will very readily be seen that tower construction had to be adopted for even

pressure, or the maintenance of a very expensive and sometimes undependable pump system.

It was, therefore, decided to construct an elevated standpipe or reservoir. Bids were taken on a steel tower and steel standpipe. This at the best would never have been anything except a standpipe, allowing but limited chance of beautification, and would always have been a constant eyesore to this community, particularly so on account of its being the tallest object on the sky line and, therefore, the most noticeable. It was, therefore, thought advisable to take bids on concrete construction with the final result that this class of material was adopted.

VIEW OF 100,000-GAL. REINFORCED CONCRETE WATER TANK AT ALTON BEACH, MIAMI, FLORIDA.

Through the able management of the gentleman intrusted with this work, Mr. August Geiger, Architect, of Miami, Fla., and the co-operation of Mr. John B. Orr, plasterer, a very pleasing architectural result was obtained. It may be worth mentioning that a saving, though slight, in cost was effected by the use of a reinforced concrete tower, curtain walls in terra cotta tile and a reinforced concrete tank.

Application of Hy-Rib in Alton Beach Tank

The interior barrel of this tank was laid out in a curved Hy-Rib, which was placed from tthe base up to nearly the offset line of the different thicknesses of the tank and which ultimately acted as the interior forms of the tank.

This Hy-Rib barrel was built in three courses of waterproofed cement stucco, considering the barrel as separate and distinct from the structural walls of the tank, reinforcing this not only with the Hy-Rib in the horizontal direction, but vertically with pencil rods against any possible expansion or contraction. This permitted of carrying the waterproofing in the floor of the tank up in a positive unbroken line from the bottom of the tank to the top, as each course of stucco or plaster work was laid in such manner as to prevent there being a lap or joint coming over the same point in any two courses. In other words, at no place on the inner surface of this tank is there less than two unbroken courses in thickness of cement waterproofed stucco.

The gauge of Hy-Rib was varied from a 22 to a 26, each division having been reduced toward the top, starting at 22, 24 and 26 in the top line.

VIEW SHOWING DETAIL AROUND THE BALCONY OF THE REINFORCED CONCRETE WATER TANK ON CARL FISHER'S ESTATES, ALTON BEACH, MIAMI, FLA.

By referring to illustrations of the tank at Alton Beach it will be noticed that this tank or reservoir has been turned into probably one of the most beautiful pieces of architectural construction on the island. The finish is of stucco. Some

VIEW SHOWING DETAIL AROUND DOOR IN TOWER OF REINFORCED CONCRETE WATER TANK, MIAMI, FLA.—NOTE STUCCO FINISH.

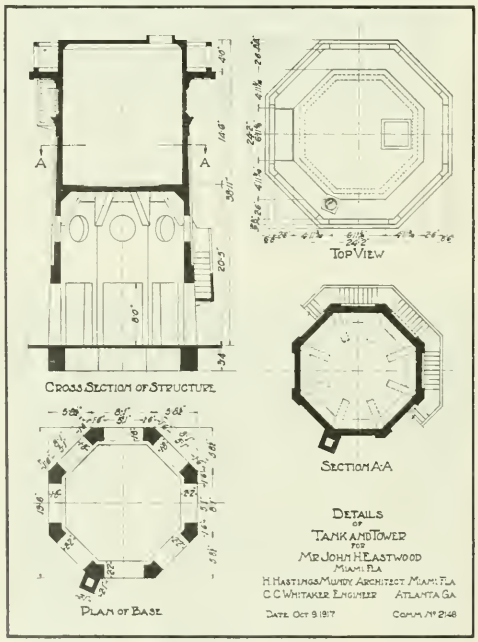
parts of this work have been accomplished by precasting the ornamentation; other parts by run moulds with the base or background in a rough cast stucco work. The color scheme adopted of fawn background with lighter moulds and white base and door frame adds greatly to its beauty.

A great deal of credit is due Mr. Orr, who is an artist in more ways than one in the use of stucco and ornamental plaster work, as his co-operation with Mr. Geiger made it possible to produce a structure which from a standpoint of beauty possibly is not surpassed by any structure of its kind in existence.

This was the first of this type of structure constructed and has proven so satisfactory in every respect that, with minor changes, a second tank of the same type is now nearing completion.

The Eastwood Tank at Miami, Fla.

Another type of ornamental tank or reservoir that shows still further the possibilities of reinforced concrete in this class of work is the reservoir or house supply tank designed by Mr. H. Hastings Mundy, Architect, also of Miami, for Mr. John H. Eastwood's estate in that city. A construction view of this structure is shown herewith, and, in the hope of showing still further the elasticity of this kind of designing work, a reproduction of the architect's detail has been used.



EASTWOOD REINFORCED CONCRETE TOWER AND TANK AT MIAMI, FLA.

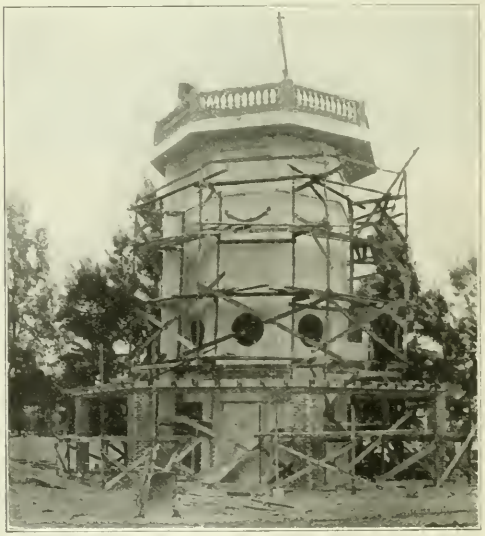
This structure will serve several purposes. Primarily it is the source of water supply for the entire building equipment for the estate; it is also an observatory or lookout and at the ground level can be used as a garage or for many other purposes.

The general architectural appearance of this structure will be very pleasing, most particularly as it harmonizes with and is of the same general architectural type as the remainder of the structures of the estate.

Water-Proofing Concrete Tanks

It may be of interest to mention that the waterproofing of all of these structures has been of an integral nature, either throughout the entire mass of concrete in the walls and floor of the tank or by the construction of an inner waterproofed stucco shell on curved Hy-Rib lath. In all cases this type of waterproofing of the tank barrel has proven satisfactory and has allowed of a marked saving in time and first cost. The adverse condition that nearly always prevails due to the use of any type of membrane inner coating was eliminated by the integral waterproofing. All materials now on the market of a membrane nature applicable for this purpose are either a composition of coal tar and mineral oils to which in a very large number of cases a creosote compound is added, or a material to which is added other chemicals, as a usual thing of a mineral nature. Any one of these compounds is bound to taint the water more or less, particularly if they are used simply as a membrane and not protected on the inner face by a stucco, which should be integrally waterproofed, thereby preventing the pollution

ARCHITECT'S DRAWING OF EASTWOOD REINFORCED CONCRETE OBSERVATORY AND WATER TANK—TOWER AT MIAMI, FLA.



CONSTRUCTION VIEW OF EASTWOOD REINFORCED CONCRETE OBSERVATORY AND WATER TANK TOWER AT MIAMI, FLA.

of the water contained in the tank. Too much attention cannot be given to this feature of the construction as the entire success of the venture or problem depends on this part of the design, specifications and workmanship.

It has been the purpose of this article to bring to the attention of the many readers of this paper not only the advisability of tank construction in reinforced concrete, but to show the wide range of results that can be obtained by its use.

There are so many points of advantage in the use of this material for this purpose that it hardly seems necessary to go over them. A word of caution, however, may not be amiss—do not think that because a contractor can construct a concrete wall he can necessarily construct a concrete tank, for often this is not the case. One cannot take too many precautions, both in the design and the construction of work of this nature, to insure a satisfactory structure.

PAVEMENT DESIGN AND CONSTRUCTION

Bituminous Pavements, Adaptable to Various Conditions, With Special Reference to Type and Thickness

By L. Kirschbraun, Ch. E., Director Chicago Paving Laboratory, 160 North Fifth Avenue, Chicago

This discussion is restricted to that class of bituminous pavements more generally employed in high-grade construction, in which the wearing surface is produced by mechanical mixture under more or less controlled conditions.

Some Pavements Foredoomed to Fail

It has been stated that many a bituminous pavement has been a failure before being actually constructed. This expression is frequently only too true, and apparently refers to the more or less prevailing custom in municipalities of determining upon types of bituminous pavement, with little or no consideration or thought of the conditions involved. In some instances, the deciding factor of selection is the persuasive effect of ill-judged promotion, which is often more interested in pushing a certain type of construction and meeting certain competition than concerned with the adaptability of the proposed construction to conditions in view.

Without careful predetermination of type of pavement, based on wide experience and intimate knowledge of conditions, all subsequent value of specifications, plans and actual care of construction may be practically nullified.

Underestimating Traffic Conditions

A very frequent mistake which is made is to underestimate traffic conditions to which prospective pavements will be subjected. This refers not only to volume of traffic which will use the pavement immediately after completion, but also to volume and weight of traffic which must be anticipated by changing conditions. The tendency to underestimate traffic is so general that engineers who design or select types of bituminous pavement should consider this foctor to the extent that errors of judgment, if any, should be in the direction of safety, resulting in building too well rather than not quite good enough. Pavements which may be thoroughly satisfactory under certain conditions of traffic may fail sharply and quickly when subjected to an intensity or weight of traffic which the type or thickness of construction is unable to accommodate.

Basing Design on Judgment and Experience

The designing of engineering structures is usually predicated upon knowledge of the exact forces to be imposed and upon scientific data with reference to the properties of various materials and combinations to withstand predetermined conditions. In designing or selecting a pavement, however, no such data is available, either as to the exact conditions imposed, or as to the ability of the materials employed to comply with these conditions. The selection of bituminous pavements, therefore, has been left to experience rather than to exact determination. In other words, the planning of a pavement for given conditions still remains a matter of judgment in which the variables are type of elements and their thickness. In spite of this, however, an analysis of the function of elementary structures composing our pavements, together with a general understanding of the action of traffic forces, will assist in the determination of the type and thickness of pavement to be selected. Until the vast field of research dealing with the mechanics of traffic and the physical behavior of paving materials under the forces imposed by traffic is thoroughly explored, there is afforded no means of design or selection of bituminous pavements other than experience and good judgment applied in the light of general principles of traffic action.

Traffic Forces

In considering the action of a pavement structure designed to sustain traffic, it must be remembered that in the final analysis, aside from ease of traction, a pavement is only a means of transferring indirectly to the subgrade the forces of traffic.

The forces imposed by traffic are variable, more or less undefined, and may only be described in general terms. Pavements must carry live and dead loads of both rubber- and iron-tired traffic. Dead loads call into action the element of compression, and requires distribution of the loads to the subgrade without breaking through the pavement structure. The action of live loads in addition results in impact which tends to shatter the bond between the particles of aggregate. There are developed thrusts, proportionate in intensity to speed, weight and nature of springs and tires with which the vehicles are equipped. Such thrusts give rise to horizontal components in the direction of traffic, tending to move the surface on the base. The action of moving traffic brings into play attrition and compression of more or less plastic surface ahead of the wheels. A more recent effect of great intensity of light motor vehicles is observed in the tendency to produce lateral displacement of the surface, resulting in grooving or rutting of the pavement through internal movement of the plastic surface to either side of the rounded tire, as illustracted in the accompanying half-tone. The cause of this action may be well illustrated in observing the wheel of a motor car as it passes over a wet pavement. It will be noticed that the advancing wheel, with its rounded tire, exerts a force which displaces or splashes the water laterally on either side of the tire. This force, acting upon the plastic mixture, produces ruts in a similar manner by lateral displacement where traffic is confined to light motor vehicles only.

A discussion of the adaptability of various combinations of pavement elements to withstand the traffic forces general-

ly outlined, and the effect of modifications of thickness in this direction will serve as a guide to selection.

Elements of the Pavement

The elementary structures of which a pavement is composed are (1) foundation, (2) intermediate course, (3) wearing surface. The function of the foundation is to support the wearing surface so as to distribute loads and shocks to the subgrade. The fonndation may be of broken stone or macadam, concrete, bituminous concrete, mixed or poured, or old pavement, such as brick or granite block.

The function of the intermediate course is to provide stability for the wearing surface—means by which the wearing surface will be stiffened or reinforced against the tendency of traffic to produce forward displacement. This intermediate course is sometimes a paint coat, but more generally a binder of either the open or closed type.

SHEET ASPHALT SURFACE SHOWING GROOVES PRODUCED BY LARGE VOLUME OF LIGHT MOTOR TRAFFIC.

The wearing surface receives all traffic forces directly, transmitting them to the underlying structure, and must maintain an unbroken surface against shocks and impacts which tends to disintegrate it. The wearing surfaces are of variable type, based upon aggregates ranging from fine to coarse, with intermediate combinations, as in Topeka mixture.

Pavement Elements in Relation to Traffic Forces

It will now be pertinent to consider these various elements of the pavement structure, with a view to determining to what extent the various kinds or their combinations behave in connection with traffic forces previously described.

Foundations

Given a well compacted and well drained subgrade, any type of foundation referred to above may be prepared of sufficient thickness to transmit loads and shocks to the subgrade in such a manner as to provide against breaking down. Of the various foundations employed, that of Portland cement is most generally used. This will distribute loads to the subgrade with a minimum of thickness, and with least regard to unevenness of subgrade. On account of its strength and rigidity, it requires less complete contact with the subgrade than any other type of foundation. It necessitates least attention to details in construction. Broken stone, macadam and bituminous concrete foundation will distribute loads over less areas of subgrade than will concrete. No experimental data is available covering the distribution of loads to subgrade through these foundations, but from the general nature of the material it can be safely observed that the area of distribution through these various types of base will be greatest in the order named, i. e., concrete, bituminous concrete, macadam and broken stone. This distribution of loads, however, may be modified in the concrete base by the lack of flexibility which may concentrate upon high points in the subgrade an excessive load, causing the entire weight to be carried over points unsupported by the subgrade. On the other hand, a broken stone or bituminous concrete base will seek solid contact with the subgrade, bringing into play only forces of compression.

Concrete Foundations

Concrete foundations are usually made 5 or 6 ins. thick. Sometimes a 4-in. base is laid, but where unusual conditions of subsoil pertain or an unusually thick bituminous covering is employed, this latter depth of concrete base can hardly provide a sufficient factor of safety against constantly increasing loads. Even a 5-in. base, with 2½ in. of covering is now giving indication of proving inadequate in larger cities where light traffic streets are occasionally subjected to heavy truck traffic. The possibility of increasing the strength of a light base by richer mixture must be considered against an increase of thickness of a leaner mixture, the latter having the advantage of distributing the loads over greater areas of subgrade.

Broken Stone or Macadam Base

As a practical proposition, a broken stone or macadam base for bituminous surfaces should be of substantially greater thickness than concrete base to withstand similar conditions of traffic. This additional thickness should correspond to at least 50 per cent. increase over concrete. In addition, it is not desirable to use a macadam base without it having been subjected to traffic and permitted to shrink and compact until free from further movement. For this reason, a new macadam base is seldom employed as a foundation for a bituminous pavement, but an old macadam base of sufficient depth of metal and sufficiently compacted by traffic with suitable drainage becomes an excellent foundation. Given the equivalent of thickness as compared with concrete, it has the advantage in that expansion and contraction is taken up by the individual particles of the base. On the other hand, in the concrete base, these forces produce cracks at greater or less intervals which are duplicated in the top wearing surface with considerable readiness.

Bituminous Base

The bituminous base, mechanically mixed, may be considered an improved macadam. It has the decided advantage over other types of foundation of becoming bonded with the superimposed bituminous courses, thereby increasing the stability of the surface and preserving it from the action of water below. However, its use must be restricted to subsoil conditions which will permit adequate drainage and uniform support underneath.

Old Brick and Block Pavements

Brick and old block pavements, laid on concrete, macadam and sometimes upon other brick, have been very satisfactorily employed as foundation for bituminous surfaces. Such foundations have the advantage of distributing loads and shocks to even greater areas of subgrade on account of the added thickness of brick or block between the old base and the new surface. Such a foundation likewise is free from the tendency to produce cracks in the wearing surface. Its use must be restricted, however, to conditions where the brick or block are firmly anchored, and need not be distributed in the application of the wearing surface. A substantial element in the usefulness of such a foundation resides in the length of time it has been under traffic, and degree to which it has become consolidated and compacted—and in the case of 2-course brick, the character of the subsoil underneath. In the

latter construction, however, it is unwise to resurface a 2-course block pavement, unless traffic anticipated is assuredly of only the mildest character.

Intermediate Course

Only two types of intermediate course have been employed in recent years: First, a paint coat consisting of asphalt cement dissolved in a suitable solvent, generally naphtha; and, second, the so-called binder course, comprising a mixture of large aggregates with bitumen. The paint coat has been used very little, and its value, as a practical proposition, is problematic. It is difficult of application over a rough surface, such as concrete, having a tendency to collect in pools that remain solvent until after the surface has been applied. In order to insure adhesion to such a base as concrete, requires a condition of freedom from dust and moisture which is very seldom obtained. It has been more satisfactorily used in resurfacing over brick, and to still better advantage in covering old bituminous compositions. There the smooth surface permits uniform distribution of the paint coat and the solvent action of the paint affords opportunity for complete adhesion. It is therefore only in the latter condition that the paint coat should be used as an alternative for the mechanically mixed binder course.

Open and Closed Binder Course

Binder course has been of two types, open and closed. The closed binder is superior to the open type in that greater structural stability is secured and the voids are filled against compression of the wearing surface into them under traffic. The binder course induces stability for the wearing surface in two ways: (1) by frictional contact of its rough, large aggregate against the base; (2) through its mechanical structure, which, on account of the locking of the large aggregate, resists internal movement. In addition to acting as a stabilizing course, it has the function of a shock-absorbing medium. This latter function will be performed in proportion to the thickness of the course. It is therefore apparent that careful attention must be paid to the binder course, and its thickness and stabilizing character should be advanced in proportion to the intensity of traffic. The value of this binder course has not been fully appreciated in connection with the preparation of surfaces which of themselves do not have the internal or structural stability necessary to resist displacement.

Thickness of Binder Course

The thickness of binder course ordinarily employed is 1 to 1½ ins. It is questionable whether an inch of binder provides a sufficient safety factor under present conditions for even light traffic. With appropriate thickness of top, an inch and one-half of closed binder would provide a much more desirable minimum for light traffic, with all factors pointing to thickness of 2 to 3 ins. to satisfy more severe conditions.

Where bituminous base is used and a positive bond is secured between base and superimposed courses, no binder is necessary, inasmuch as the foundation itself acts as a stabilizing element.

Wearing Surfaces

The wearing surfaces, which actually carry traffic, and initially receive the forces imposed thereon, are characterized by size of aggregates employed, varying from fine aggregate, as in a sheet asphalt pavement, to a comparatively large stone aggregate, as in the true concrete types. Between the two extremes of fine and coarse aggregate lie several types of wearing surfaces, such as the Topeka mix and grit mixtures, with varying amounts of small stone. Sometimes these wearing surfaces are placed directly upon the foundation, and sometimes upon an intermediate course, depending upon the type and character of surface and the foundation.

Types of Wearing Surfaces

Various types of wearing surfaces are more or less advantageously employed in connection with different kinds of traffic. Traffic such as that of iron-tired vehicles, which exerts considerable abrasive action on a surface, is best resisted by that type of surface containing the finest aggregate. This is likewise true in connection with traffic in which impact, as well as abrasion, of iron tires plays a substantial part. Large aggregates under impact are prone to shatter, permitting the entrance of water and the subsequent more rapid destruction of the surface.

On the other hand, mixtures of fine aggregate do not possess in themselves the structural stability contained in mixtures comprising large aggregates. For this reason, surfaces of the former must be laid upon a reinforcing course (binder), to which the wearing surface is firmly bonded, and which adds a stabilizing element against the effect of those traffic forces which induce displacement. In considering such type of construction as sheet asphalt, modifications as to thickness may be based again upon the traffic conditions to be encountered. A pavement which is not subjected to traffic of an abrading character, but rather to traffic of motor trucks with rubber tires, requires less thickness of wearing surface and greater structural stability secured through the intermediate or binder course.

A further condition must be considered with reference to the character of motor driven vehicles, distinguishing between commercial vehicles and boulevard traffic, restricted to lighter but more swiftly-moving vehicles. Traffic of this latter character has a tendency, as indicated before, to produce lateral displacement, which results in the formation of parallel grooves or ruts in the direction of traffic. Such condition is best met where traffic of this kind is intense, by incorporating with the fine aggregate a percentage of stone, proportionate to the intensity of traffic, which serves to increase the internal resistance to flow under the rounded face of the tires. Mixtures made of large stone aggregate, i. e., the true asphaltic concretes, are more particularly adapted to this type of traffic.

Wearing Surfaces of Intermediate Type

Wearing surfaces of the intermediate type, containing varying amounts of small stone aggregates, have been laid very widely in recent years, the usual practice being to place such surfaces directly upon the foundation. Experience has shown that unless such surfaces or mixtures contain a preponderating amount of small stone, or approach true concrete (grit mixtures), they do not have stability upon the usual form of base to resist displacement of any but the most moderate traffic. This type of wearing surface has been generally laid 2 ins. thick. It is not well adapted to traffic, having a substantial abrading action for the reasons previously stated, nor does it possess the stability of itself to carry any volume of motor traffic without displacement.

Another type of surface containing intermediate aggregate are grit mixtures, comprising an aggregate predominating in small (usually ¼-in.) stone and constituting, with proper admixture of fine aggregate, a true concrete of miniature type. Such mixtures are decidedly more stable than Topeka mix, and are well adapted without a binder course to medium traffic of a mixed character.

Using Intermediate Binder Course to Give Stability for Heavy Traffic

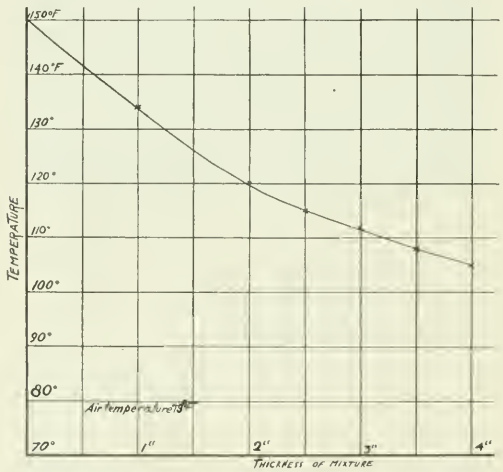
The lack of necessary stability for heavy traffic, characteristic of the Topeka mix (more properly, stone-filled sheet asphalt), can be corrected by the use of an intermediate binder course, which will add the necessary stability as it does in the case of sheet asphalt. Surfaces of this kind have been laid in the past few years to considerable extent throughout the Middle West. Such a combination of wearing surface and intermediate course possesses some advantage over other types wearing surface through increased stability against forward

displacement, as well as through increased stability against the grooving effect of swiftly-moving light vehicles.

It might be observed here that any surface laid upon a non-bituminous base of, say 2 ins. thickness, without an intermediate course, cannot be considered as possessing wearing surface to the full extent of its thickness. This is true for the reason that when reduced to a certain minimum of thickness, either by attrition or by displacement, it will break up through the shocks of traffic long before it is worn through. However, if laid upon a sufficient depth of intermediate course, a wearing surface of 1½ ins. will provide thickness ample for the most severe traffic.

Effect of Thickness of Bituminous Courses

As a general proposition, thickness of bituminous courses, both intermediate and wearing course, is effective against traffic forces in several ways. Increasing the thickness (1) decreases intensity per square inch of loads transmitted to the base, (2) decreases the intensity of those forces acting at the contact plane between base and intermediate course, tending toward displacement, (3) provides greater mass of shock-absorbing medium, (4) increase of thickness decreases the thermal effects which render mixtures less stable with ascending temperature. Demonstration of the above principles will be apparent from consideration of any simple diagram indicating the extension of a pressure cone through various thicknesses of surface to the base.



TEMPERATURE AT VARIOUS DEPTHS OF BITUMINOUS MIXTURE WITH A CONSTANT SURFACE TEMPERATURE OF 150 DEG. F. FOR 5 HOURS.

It is apparent, therefore, that the determination of the thickness of the intermediate and wearing courses becomes a very important factor in designing a pavement for a given intensity of traffic. From this may be deduced the proposition that for a given intensity of traffic a thick bituminous layer requires less depth of foundation than does a thin bituminous layer. Likewise, given a certain thickness of foundation, for example, 6 in. of Portland cement concrete, the demands of heavier traffic can be met advantageously by employing a thicker intermediate course to lessen the intensity of traffic forces transmitted to the base.

Effect of Seasonal Heat

Another point which has been most generally overlooked is the effect of seasonal heat upon bituminous mixtures. A bituminous mixture softened by heat becomes, as is well known, less stable, and more susceptible to those traffic forces which produce displacement. A thin surface will become heated through more quickly than will a thick surface. Some experiments undertaken to illustrate this proposition are given herewith, showing graphically temperature at various depths of bituminous mixture, the surface of which has been subjected to constant heat. This shows that a thick surface will be cooler at point of contact with its foundation than will be a thin surface, thereby becoming more stable, and in effect, *behaving as if it were laid at a lower penetration.* This reduction of thermal effect with increased thickness not only adds stability, but, it is apparent, also tends toward distribution of traffic shocks over greater areas of foundation.

Summary

To sum up, the most distinctive feature of modern traffic is the thrust of heavy motor-driven vehicles in producing displacement. Bituminous pavements must be designed to provide increased resistance to such displacement. The problem of providing a surface which will resist wear is comparatively simple, and the nature of traffic serves as a guide to the type best fitted for given conditions. Motor traffic will permit of less thickness of wearing surface, but, making more demands upon stability, necessitates greater thickness of binder, with corresponding care in composition. Binder course in its increased thickness may in fact be considered as a bituminous base transferring to its non-bituminous support the effect of traffic in diminished intensity.

When the wearing surface is of such type as requires no stabilizing course, the thickness should be increased in proportion to the intensity of traffic for reasons previously given.

Increasing the thickness of bituminous covering will to a large extent obviate the necessity of a heavier base which would otherwise be required by constantly heavier weight of traffic.

Essentials of Good Practice in the Construction of Concrete Roads

By Edwin K. Borchard, Engineer, Atlas Portland Cement Co., New York City

In any road the first and most important consideration is that of permanence. To be permanent the road must have sufficient strength to bear the heaviest traffic that will be imposed upon it. In addition to this, it must possess a surface which will resist abrasion and always be even and hard.

The Concrete Road

A concrete road is simply a continuous slab of concrete, composed of sand and stone, bound together in a monolithic mass by Portland cement. Owing to its strength, the concrete road slab distributes the highly concentrated load of vehicle wheels over a large area of the subgrade. Portland cement, the binding material in concrete roads, holds the sand and stone firmly and rigidly together, thus resisting abrasion and the dissipation of the fine particles of the surface. Concrete is impervious to water, thus making the concrete road an all-year-round road. Storms and alternate freezing and thawing have no effect upon concrete.

Low Tractive Effort Required

The even, hard surface of concrete roads permits heavy vehicles to be moved at the minimum of tractive effort. Experiments just completed by the California State Automobile Association demonstrated that the pull required to move a ton load over a concrete road was 27.6 lbs. A water-bound macadam road required 64.3 lbs., a gravel road 80 lbs. and a good dirt road 95 lbs. This means that concrete roads require only from one-half to one-fourth the power for hauling necessary on macadam or dirt roads.

Low Crown

Since concrete roads are impervious, they need not be so highly crowned in the center to shed water. The average

crown of a 16-ft. road is only 2 in. at the center. This flat crown distributes traffic more uniformly over the entire road width, for the tendency of drivers is to keep to the center or top of a heavily crowned road, thus causing increased wear and even rutting at that point.

Maintenance

The low maintenance costs on concrete roads are phenomenal. The principal item of maintenance is the cleaning and filling with bitumen of the few cracks that may develop in the first two or three seasons. These cracks are mostly longitudinal, and, if properly attended to, in no way detract from

CONSTRUCTION OF LINCOLN HIGHWAY ON ELKHART-GOSHEN, IND., ROAD.

the durability of the road. Cracks are ordinarily caused by slight settling of the subgrade, due to improper preparation or drainage.

In the United States and Canada the amount of Portland cement concrete roads built has had a tremendous increase, as is shown in the following table:

Year	Sq. Yds.
Prior to 1909	799,390
1909	561,271
1910	1,313,449
1911	2,069,445
1912	5,295,447
1913	9,596,286
1914	14,815,034
1915	16,936,137
1916, approximately	26,000,000

Construction of Concrete Roads

Concrete roads are divided into two general types: One-course and two-course. One-course roads consist of a single thickness of concrete, usually 6 in. thick at sides and thickened at the center. This type is the one most used and is to be preferred. Where good, hard, durable sand and stone are not procurable locally it is sometimes the practice to construct the road in two courses—that is, a base course of the less durable aggregate and a thinner top course of a superior grade of aggregate shipped in from the nearest source. The base

ROLLER FINISHING A CONCRETE ROAD.

course and top course are laid practically at the same time, so that they will consolidate and bond together in a solid mass.

Subgrade

As in all types of roads, the preparation of the subgrade is an important consideration in building a concrete road. The grade should be established so as to obviate, as much as possible, any fills. Where fills must be made, the material should be deposited and compacted in thin layers. Where especially deep fills are necessary it is good practice, if possible, to allow the fill to settle through the winter before constructing the road upon it. Care must be exercised to remove all soft spots in the subgrade, so that it will be uniform in density and hence will not settle unevenly.

Drainage

The question of drainage must receive special attention. The methods to be employed are determined, of course, by the conditions peculiar to each road. In general, the open lateral ditches at each side of the road will suffice, if they are well built and maintained. Where more drainage than this must be provided, this consists of cross-drains connected with the side drains. Insufficient drainage exposes the road to danger of frost action, heaving and cracking.

Concrete Slab Thickness

The thickness of slab at the center line of the road is dependent upon the width of road. In a typical cross-section for a one-course road it should be noted that the thickness at edges, under ordinary conditions, is never less than 6 in.

Reinforcing

The practice of reinforcing concrete roads with heavy wire mesh or expanded steel is increasing. The reinforcing steel prevents the formation of large cracks due to uneven settling of the subgrade or insufficient drainage. The standard specifications for concrete roads require all roads over 20 ft. in width to be provided with a reinforcement weighing not less than 28 lbs. per 100 sq. ft. The reinforcing is placed 2 in. from the top of the road.

Joints and Joint Fillers

To allow for expansion and contraction of the concrete slab, due to temperature and moisture changes, it is necessary to provide transverse joints. These are usually located from 30 to 50 ft. apart and constitute a complete division in the slab. Two types of joints are employed, one protected at each side by vertical steel plates anchored to the concrete by lugs imbedded therein, the other type having these plates omitted. The use of protection plates is determined by the character of traffic to which the road is subjected. The function of the protection plates is to prevent spalling or wearing of the concrete at the joint. This is necessary where traffic is heavy.

CURING A GREEN CONCRETE ROAD BY THE PONDING METHOD.

With either protected or unprotected joints there must be used an elastic joint filler to prevent the entrance of water. This joint filler is usually ¼ in. in thickness and consists of a single strip of fiber matrix and bitumen. This strip is placed during construction and is about ½ in. wider than the depth of the pavement. This allows the filler to protrude above the upper surface, and it is then ironed down by traffic so that it extends over both of the slab edges, effectually protecting them.

Forms

The only forms required are the side forms of wood or steel plates (steel is preferable). These forms are staked to grade and carefully leveled before the concrete is placed. A transverse form is used at each joint location. To this is tied the joint filler. The concrete is deposited on each side of this

form and then the form is removed at once, leaving the filler in place, which thus divides the concrete through its entire depth.

Materials

The Portland cement is always specified as required to meet the Standard Specifications of the American Society for Testing Materials.

Extreme care is given to the selection of the fine and coarse aggregates (sand and stone), since upon these depend the wearing qualities of the concrete, for the cement acts as a binding material. Sand is defined as quartzite grains or other equally hard material, well graded from fine to coarse. The largest particles must pass a ¼-in. mesh screen and there must not be an undue amount of very fine particles. Sand for use in concrete roads must be of superior grade to that ordinarily employed in building work; it must not contain vegetable matter nor more than 3 per cent by weight of clay or loam.

Coarse aggregates consist of hard, durable crushed stone or pebbles. The largest pieces must not be over 2 in. in diameter, and all must be clean and free from dirt or loam. Bank-run gravel (sand and pebbles, naturally mixed just as it comes from the bank) must not be used.

Proportioning and Mixing the Concrete

The proportions now almost universally used for concrete are 1 part Portland cement, to 2 parts sand, to 3 parts crushed stone or pebbles. All materials are measured by volume and one bag of cement is considered as 1 cu. ft. The measuring of materials is very carefully done, as this is an absolute essential in securing a uniform quality of concrete.

The mixing of the concrete also should receive special care. The mixing must be done in a mechanical batch mixer and must continue for one full minute after all materials are in the drum. The consistence of concrete should be mushy wet—having a jelly-like appearance, in which no free water is visible.

Placing and Finishing Concrete

Before the fresh concrete is placed the surface of the subgrade should be well wet down, although not enough to show pools of standing water. This wetting prevents the absorption of the water from the fresh concrete. The concrete is then deposited to the full width of the road in successive batches. When reinforcement is used the concrete is placed within 2 in. of the full thickness, the reinforcement laid in place and the remaining 2 in. of the concrete at once deposited.

The fresh concrete is leveled and brought to the proper contour by means of a "template" consisting of a heavy board with bottom cut to shape. This template rests upon the side forms and is drawn forward over the fresh concrete, thus bringing the concrete to the proper crown. As the template moves forward it is also drawn back and forth, thus giving a sliding motion which serves to compact and even up the surface.

The finishing of the top surface is accomplished in several ways, depending upon conditions and the preference of the engineer in charge. The method first used and still most common is to float the surface lightly with a wooden float. The workman is supported on a "bridge" over the road, since no one must walk or stand in the fresh concrete. A wide, heavy belt, with handles at each end, is also used to finish the surface. It is drawn back and forth over the road. The latest method of finishing brought forward is rolling by means of a light sheet metal roller at the end of a long handle. With either of the last two methods it is usually necessary to do some floating in spots which cannot be easily reached, and at the joints. The main point in finishing is not to try for too smooth and slick a surface. A level, even surface is what is needed.

Protection and Curing of New Road

Fresh concrete must not be allowed to dry out too rapidly, and for this reason the road must be wet down and covered to protect it from winds and the direct rays of the sun. As soon as the concrete is hard enough to stand sprinkling without pitting, it is constantly kept wet until sufficiently further hardened to bear the protection material. This protection consists in most cases of a layer of earth 2 or 3 in. thick, kept constantly wet. Where earth for covering is not easily obtainable, the road is flooded with water to a slight depth, the water being kept in place by small earth dams on each side of the road.

The protection material must remain in place for at least ten days and the road not open to traffic for at least fourteen days—longer if the weather conditions are not favorable to the rapid hardening of concrete. Special precautions should be taken to bar off all traffic until the concrete has been allowed to attain the strength necessary to resist the load and abrasion it will have to bear.

Viable Roads Necessary Quickly for War Efficiency

By Lt. Col. James W. Howard, C. E., Consulting and Testing Engineer on Roads and Pavements, 1 Broadway, New York

A viable road means one which is in condition properly to fulfill its function of providing safe and rapid transit of vehicles. A constantly viable road is a road, including culverts and bridges, which is efficient for traffic at all times.

Europe for many years, and now our country, has realized that one of the greatest factors necessary for preparation and prosecution of modern warfare is constantly viable roads, necessary for many purposes, among them:

Uses of Military Roads

(a) To furnish through routes for auto trucks to deliver themselves from where manufactured to the point needed for use or for export.

(b) To enable auto trucks to carry large loads of machinery, ordnance, munitions, vast supplies for military and civil purposes, directly from where first loaded to where their loads are to be used or exported; and to do so quicker and cheaper, up to at least 300 miles, than to truck supplies to a local railroad station, reload on the railroad, go by railroad to another location and there reload on trucks and deliver the supplies to the exact location needed for use or export.

(c) Viable through routes for auto trucks relieve not only railroad transit congestion, but especially the great and increasing congestion at railroad termini.

(d) To eliminate terminus railroad freight congestion at large cities by having good local roads around and radiating from large cities and export points to surrounding small towns, which enables the railroad freight stations of many small towns to be used to handle freight thus kept away from centralized large city congestion; because those roads enable auto trucks to have many places to receive freight and deliver it directly to the exact locations needed in and near large cities or on the exact export dock. The local inadequate large freight stations in the large cities are thus relieved from congestion in Europe, and must be so relieved in America. Otherwise, disaster will follow the choking and delay now prevalent and increasing in many of our large cities. The congested termini of our largest cities, holding back cars loaded and idle on miles of side tracks outside the cities, is one of the reasons why coal, for example, so necessary for our productive efficiency, can not be delivered to the consumer, and why ships can not be built faster, because waiting for materials.

Slowness of transit and congestion of the necessary supplies has lost many wars. Viable routes, furnishing sure transit and prompt delivery, have won wars and are a tremendous necessity for us now.

Experience of past wars has established the military dictum that the war preparation and continued supply of soldiers,

materials and adjuncts have three factors: First and most important in quality and quantity; second, speed of preparation and delivery; third and last to be considered is cost—for the war must be won, cost what it may.

Need for Immediate Action

Viable roads are a military necessity and a vital adjunct. They must be of good quality, quickly supplied and maintained at whatever necessary cost. This can best be done by using existing good roads, linking them up with old roads to be quickly repaired and resurfaced; also, where absolutely necessary, some old bad and weak roads must be entirely rebuilt. The national, state and county officials should now quickly select the roads in many parts of most states necessary for war and pressing domestic supplies; inspect them; decide which must be repaired, resurfaced or entirely rebuilt, to carry heavy auto truck unit loads and many of them. Then work on these roads in many parts of most states must be quickly started and rapidly continued, by fixed bid price or percentage contracts, force account or day labor, including use of prisoners (properly paid) where possible.

Four General Groups of Military Roads

The roads needed for war productiveness and deliveries and for sustaining the people during the war, can be divided into four general groups, viz:

First—Roads which are in good condition and will bear the the heavy loads and resist the wear of traffic and weather, sufficiently to be kept with attention in constant viability.

Second—Roads which have firm foundations, but have their wearing surface layers so much out of repair in spots as to impede traffic and injure automobiles. Such roads can usually be quickest (speed being most important) and cheapest put in viable condition by repairing the spots with the same kinds of materials as now compose those roads.

Third—Roads which have firm foundations, but are in bad disrepair, and need new resurfacing over large sections or the whole road, and which can be quickest and economically (considering reduction of subsequent maintenance) made viable by resurfacing them. To do this it is cheapest and quickest where possible to use local materials, such as crushed stone, crushed hard slag, gravel, sand and sometimes ground mineral filler, mixed hot in various proportions to be as dense as possible, together with suitable bitumens, such as asphalt-cements. Spread the mixture and consolidate it with heavy steam or gasoline rollers to a finished depth of at least 2 ins. at all points. It may be necessary in some cases to even up, not cut down, the old road surface by any of the established methods and materials. In some cases it is best to fill depressions and even up the old macadam or other old road surface before resurfacing, by using crushed stone or its equivalent and pouring hot bitumen on it (penetration method). The asphalt concrete or other bituminous compound thus used for resurfacing, when rolled hard, can be cooled with water and thus at once opened to traffic as the work progresses. Work can be done on alternate sides of the road and traffic kept moving.

Fourth—Roads which have no firm base and which must be rebuilt, including grading, foundation and wearing surface layer. In such cases, where traffic can be safely blocked and sent by other roads for some time, it is slow but feasible to construct new roads with various materials needing time to use, such as Portland cement concrete foundations, brick, stone blocks, etc. In some cases where entire new roads must be built some time can be saved by constructing crushed stone or very coarse gravel foundations poured with suitable hot bituminous binders or cements.

While the foregoing is suggestive, local conditions will often compel other methods and materials to be used.

The hundreds of miles of viable roads now necessary for military efficiency will also furnish our country with a great asset and help in the post-war period, when they will be needed to increase economic efficiency then necessary to help pay the cost of war and re-establish and maintain prosperity.

Selecting Road Men in North Carolina

By D. H. Winslow, State Maintenance Engineer, North Carolina Highway Commission, Raleigh, N. C.

All states, counties and towns must pay for a trained road man or else they must develop such a man, if they expect to secure results on the highways. In any event, the taxpayers foot the bill. Many states are unable or unwilling to pay for trained men and are obliged to develop their own men. The success of the work depends on the men selected for the work, and the method of selection is of vital importance in building up an efficient organization. Many of the states are under civil service, but most of them are not. The civil service is more or less cumbersome, and many competent men could not pass the test for physical or other reasons.

The State of North Carolina has adopted a novel way of selecting its men that may prove of interest to others. A confidential file has been introduced which contains the following information relative to each applicant for a position: Name, age, position desired, salary expected, could report, employed at, P. O. address, 'phone, telegraph, application expires, and date of application.

It saves hours of work going over hundreds of applications to find a suitable man who will take a position at the salary that can be paid. By classifying the men at once, according to salary, the available men are known. The essential facts are shown and no time is wasted on men whose cards indicate they do not fall within the range of the position. All applications are destroyed on the date they expire. The list is therefore always up to date. The available men are notified and permitted to file any new information they care to submit. It is then an easy matter to examine the candidates and pick out the desirable man. No time is wasted with any other men. A man may have on file a card for several positions, if he so desires. A man may at any time recall his application and submit one that is up to date. The state thus secures a man at his own figures and at a price it is willing to pay for such service.

This list is of value to the state, the counties and the towns. It includes engineers, foremen, patrolmen and all classes, skilled and unskilled. No foolish or unnecessary questions are asked, and it is business from the start. Until there is an actual vacancy the man is not considered and none of his time wasted chasing up visionary prospects. No reference to politics, religion or place of birth is made and the man is selected on his merits alone. Practically all the men are selected after a personal interview, after the nature of the position and its requirements are fully known. The system has thus far given excellent results and the men feel they have been given a square deal. A man hired at his own figure for the special position he seeks is likely to be satisfied, and a satisfied workman usually shows results. A man may, if he elects, give a minimum and maximum salary on his application, thus covering a greater range of prospects. The system saves on clerical services and is a great saving of time in the office. It also saves on space by having on hand, in compact form, all information necessary to locate candidates on short notice when vacancies occur. It does away with long files of references, etc., until they are actually in demand. The selection of the right man is half the battle in solving the road problem, and anything that simplifies it should be given attention.

WATER WORKS MAINTENANCE AND OPERATION

How a Deficit of $2,000 Was Changed to a Surplus of $27,000 in One Year at the Waltham Water Works

By Bertram Brewer, City Engineer, Superintendent of Water Works and Sewers, Waltham, Mass.

The Waltham, Mass., water department, which does a gross business of about $100,000 annually, finished the year 1915 with a deficit of $2,428.53. At the end of 1916 this deficit was changed to a surplus of $27,243.54. How was it brought about? This is a live question, and the answer is an old-fashioned one—by strict honesty and *by the introduction of business-like methods in the maintenance of the department.*

Brief Description of Plant

Before explaining the changes that were introduced to effect this saving, a brief description of the plant is in order. It consists of two pumping stations, operated independently with horizontal, cross-compound, fly-wheel pumps of an actual average duty of 90 and 100 million ft. pounds, respectively. Each pump draws water from a large well constructed in an extensive area of water-bearing gravel, bordering a river which flows through the city. The average daily consumption is about 2,260,000 gal. and it costs between $14 and $15 per 1,000,000 gals. to deliver it into the reservoir. Of the two reservoirs, one, an open one of 10,000,000 gal. capacity, was partially abandoned about ten years ago, owing to organic growths resulting from the exposure of a ground water to the light, but is kept full as a standby supply in case of accident or unusual consumption. The other is a 2,000,000 gal. concrete covered reservoir or tank, 100 ft. in diameter and 40 ft. high on higher ground nearby. The mains in use are 60.55 miles in extent and serve a population of about 31,000 persons. The pipe is cast iron, of good quality, and well laid. There are about 4,300 services. They were all laid by the city and are mostly of cement lined, wrought iron pipe, though there was a period of ten years or so when the department fell from grace and put in galvanized iron. As Waltham water contains a considerable amount of free carbonic acid, brass and galvanized iron pipes are quickly corroded.

Meterage

About 65 percent of the services are metered. The average daily consumption per person is about 71 gals., as against 90 when metering was seriously begun. An average of about 10 percent of the services has been equipped with meters each year for the last three years, and this policy, no doubt, will be continued until all are metered. The meter force has an upstairs room in a brick building in a service yard on the railroad in the center of the city, used as headquarters for the different maintenance gangs. The work at the shop is in general charge of an assistant, who has particular charge of the stock and who acts as timekeeper to check up the time of the men, the stock used, and the diagrams showing measurements of and ties to all construction or repair work. The force at the shop includes, in addition to the meter division, the service division, and the construction and maintenance division. As the water and sewer departments are under one head, there is a fourth division, detailed to sewer work.

The pumping station force is under the control of a chief engineer, who is directly responsible for the upkeep and operation of the stations, and lives in a house adjoining one of them. These stations are both in the outskirts of the city, 1¼ to 1¾ miles away.

Water Rates

The charge for measured water is at the following rates per tenement:

Supplied with one faucet, a minimum charge of $5 for 2,500 cu. ft. or less; then 20 cts. per 100 cu. ft. up to 6,000; and 11 cts. per 100 for any amount in excess.

Supplied with one faucet and one closet, a minimum charge of $8 for 4,000 cu. ft. or less; then 20 cts. per 100 up to 6,000; and 11 cts. per 100 for any amount in excess.

Supplied with any number of fixtures, a minimum charge of $10 for 5,000 cu. ft. or less; then 20 cts. per 100 up to 6,000; and 11 cts. per 100 for any amount in excess.

There is no charge for the smaller meters. For 1½ in. and larger, there is an annual charge of 10 percent of the cost of installation. Fire service is free, and special fire connections are installed and maintained for sprinkler or private systems at the expense of the owner. The department pays no taxes of any sort and receives no money for fire protection, with the exception of an annual sum of $5 per hydrant. It does, however, receive payment for water furnished the various municipal departments throughout the city.

Services

The services are laid to the street line at the expense of the department; the owner pays at the rate of 40 cts., 45 cts., 50 cts. and 60 cts. per linear foot for 1-in., 1¼-in., 1½-in. and 2-in. services, respectively, inside his property, together with the actual cost of the shut-off inside his cellar wall.

Passing now to the question with which this article opened, relative to the sudden change from a business running behind financially to one that showed a big surplus, the writer will endeavor to indicate, in the brief space an article of this nature will permit, some of the principal changes that brought about this result in this particular case. Most of them are universal in their application.

Faulty Service Records Corrected

In the first place the records of the services were found to be very faulty. Many of the charges could not be explained. It was evident that there were omissions, yet there were no adequate plans to show where the error lay. Fortunately, the engineering department, which has for a long time had charge of the sewers, has kept complete plans and profiles of all the sewers by streets, with accurate location and plot of the house connections and the number of the connection allotted at the time of installation. The houses were also located and a beginning had been made toward placing the correct street number or numbers on each building. The plans are on sheets of tracing cloth, uniform in size, and are filed away in filing cases which open anywhere for the placing of a sheet in its proper alphabetical order. Work was begun immediately on plotting the water mains and services also, the appropriate service numbers were added, as well as a note to show if the service was metered, and, most important of all, every building was given the appropriate street number, something which will not change, no matter how many transfers of property occur. The books and bills have been gradually corrected as this work has proceeded, revenues have increased, and a large amount of time has been saved in clerical work thereby.

Less water has been pumped, a reduction in rates has been made, operating expenses have been reduced, yet the income has been somewhat increased because the charges have

been more correctly levied. A cut of a typical sheet is published with this article.

Department Thoroughly Organized

In the second place the department has been thoroughly organized so that each man knows better what is expected of him, necessary supplies are always at hand, and each division of the working force has every opportunity to become expert along its particular line. In a general way the organization has been indicated. It consists of an engineering division, a clerical division, a meter reading division, a pumping division, with a shop force divided into the various groups previously described. The work is so systematized that careful and complete records and locations are kept, any job finds the man best fitted to do it automatically and quickly, and careful record is made of the time occupied, material used and results, and this is preserved in the files for billing, cost accounting, and future reference. This is done on a series of printed forms or slips of uniform size, properly headed and identified by the appropriate street and service numbers. These forms have been very carefully planned and

TYPICAL SHEET OF WATER AND SEWER CONNECTION RECORDS, WALTHAM, MASS.

perfected with each new edition. It has been found that clearness, completeness and simplicity are great aids to efficiency. In every case the original notes made by the man in charge are preserved and filed. These records are a very important element in good organization. They have, among other things, proved a wonderful stimulus to the workmen. They learn to take considerable pride in keeping them, and interest in keeping the costs down and the grade of work high has been greatly augmented thereby. All this is only a way of applying the old principles of business efficiency, but it resulted the first year in the saving of many thousands of dollars. The writer's experience and observation lead him to believe that there is sore need of its application in many municipal departments.

Supplies

Then there is the question of supplies. It has been found very helpful to keep a brief record of all bills contracted under the appropriate dealer's name, alphabetically and chronologically arranged, in a loose-leaf book. This helps in acquainting the purchaser with the various dealers he trades with and the prices over a period of years. A study of this record often indicates how fast materials are used, the best time of year to buy, and the best opportunity for a good trade. In all the larger expenditures, like those for meters, coal, pipe, etc., the practice of asking for bids on the city's specifications has been adopted, with a great resulting saving.

Stockroom Established.

A stockroom was established early in the present regime. Three wooden cases were made by a local carpenter, each one containing 70 unit cubical divisions, 18x18x18-ins. Wooden boxes were purchased of a box maker to fit these units, the sizes of which vary from the large ones to take up the whole space to some as small as 18x4½x2-ins. for small meter parts. The sides of each division in the cases were grooved before erection so that horizontal partitions can be placed as needed to accommodate as many different size boxes in each 18-in. cube as a suitable distribution of the stock requires. A large quantity of material was thus discovered which could be used or repaired. Delays in searching for material are eliminated, and the men in charge of the stock can readily inventory the same and make frequent and intelligent reports as to the need of new supplies.

Water and Sewer Connections in Same Trench

Among other things which might be mentioned as saving in cost of departmental expenses is the practice of placing water and sewer connections in one trench by one gang of men, trained in the technique of both operations, the introduction of the paper plug and force pump method of cleaning services, prompt enforcement of the ordinances governing the collection of bills of delinquent water takers, as well as the elimination of incompetent or unnecessary workmen.

Changing Over from Flat to Meter Rate

The period of transition from fixture rate to meter rate is, to say the least, a trying one for any water department. It takes a vast amount of patience and educational propaganda on the part of the department to accomplish the change without a great deal of friction. As most of the difficulties that arise are due to misunderstanding, an intelligent recourse to the printing press and a series of notices as to proposed installations, precautionary measures to be taken by the owner, warnings concerning leaks and advice concerning their elimination, with information as to the exact time the new rates will go into effect, have ben found useful.

The Waltham authorities have stood behind this organization and have given the departemnt every opportunity to make good. The writer appreciates this backing and realizes how much backing of this sort means for better municipal government in America.

Municipal Jobs Must Be Made Attractive to Good Men

And this leads to a final word in concluding this brief account of the application of some well-known principles of efficiency and economy in one municipal department. Municipalities must rid themselves of dishonest and incompetent officials, but they must also make municipal jobs worth while for competent and honest men. Exceptional efficiency of management must receive consideration and encouragement. Unless there is sufficient intelligence in a community to grasp the significance and importance of superior work, there is no opportunity for a superior man. Honest administration must face a powerful element in every community which by every means, fair or foul, endeavors to secure special privileges and exemptions for itself at the expense of the other fellow.

The success of any scheme for the collective ownership, which looms large just now in the world, hinges on the human element. . It would be well for every community to possess a local Good Government Association, constructive as well as destructive, as ready to back up good officials as to condemn

the bad. When the bulk of the people intelligently and conscientiously reach this state of mind, and back it up with their votes, every dollar of the public money will be carefully expended and rates will be reduced.

Measures Adopted to Curtail Water Consumption in the City of St. Louis

By Edward E. Wall, Water Commissioner, 312 City Hall, St. Louis, Mo.

No phase of water works maintenance and operation is of more vital interest than the restriction of water consumption. Large cities, such as Chicago, Philadelphia, St. Louis, Baltimore and Buffalo, where the great majority of consumers are supplied with water at flat rates, necessarily have large per capita consumption. Year after year these increase as new buildings with modern sanitary appliances for the housing of the population are built and the old houses abandoned. How to keep the consumption within reasonable limits or to reduce it to its proper quantity has been a problem to which the water works superintendent or engineer could always apply his ingenuity in his leisure moments, if he had any, but it has more often forced itself upon his attention because of its menace to efficient service.

Effective House-to-House Inspection in Boston

House-to-house inspection, coupled with rigid enforcement of regulations in regard to defective plumbing, has been exhaustively tried in many cities—notably in Boston some 35 years ago, when Dexter Brackett organized and operated what was probably the most efficient inspection force for the purpose of reducing leaks and waste that has been essayed in this country. In one year he succeeded in reducing the average daily per capita consumption from 91.5 gal. to 68. The thoroughness of the inspection gradually decreased during the years that followed, and the system was finally abandoned in 1895, partly on account of the expense, but principally because the opening of the new Metropolitan Water Works supplied an abundance of water. Then the consumption increased to such an extent that the Massachusetts legislature passed an act compelling the city of Boston to meter all connections within a stated number of years.

Examples of Water Waste

In St. Louis the water commissioner protested against the waste of water about 40 years ago, saying, "At the lowest estimate, I believe that 50 per cent. of the water pumped into the city is allowed to run back into the river without having been put to use."

Some years ago John Ericson, chief engineer of the Chicago water works, estimated that probably 70 per cent. of the water pumped into the mains was wasted. At that time the daily per capita consumption was about 200 gals.

Pitometer Surveys and District Inspection

Pitometer surveys in various cities have uncovered great losses from underground leakage. District inspection by the Deacon system in several English cities brought about large reductions in consumption at surprisingly low expenditures.

Both of these methods have been tried in St. Louis, but the systematic house-to-house inspections for leaks and waste, carried on daily, year in and year out, have contributed more than anything else to keep the average daily per capita consumption below that of most of our larger cities.

Pitometer surveys of nine districts in different parts of the city showed no underground losses of consequence, even in localities where mains had been in service 50 years or more. District inspection, after the manner of the Deacon system, did not produce results encouraging enough to follow it up continuously or apply it to large areas of the city.

Work of the Inspection Branch

In the organization of the Water Division of St. Louis is the Inspection Branch of the Distribution Section. This branch consists of a force of 37 men, including the superintendent, 30 of whom are inspectors, who are assigned to 12 districts into which the city is divided. These inspectors are continuously on their respective districts, examining all premises for evidences of leaks or waste. Over 200,000 inspections are made per year, and more than 13,000 leaks reported, of which about 90 per cent. are repaired by owners upon being notified. About 1,500 premises are annually shut off on account of failure to make prompt repairs.

The permanent effect of such inspection lies in the thorough and continuous work done. It is evident that any cessation in vigilance would in a short time result in an accumulation of leaks and increased carelessness as to waste by all classes of consumers.

Hot and Cold Weather Water Consumption

The average daily per capita consumption of 133 gals. for the year 1917 for St. Louis is unquestionably much higher than it should be, and in a way is misleading, because the average must take into account the abnormal waste during cold weather when faucets are allowed to run to prevent house pipes from freezing, and in the summer when excessive lawn sprinkling is practiced during hot, dry weather, both of which conditions often tax the full capacity of the works. For example: The maximum daily consumption last summer in St. Louis reached 134,600,000 gals. and this winter 154,400,000 gals., while the normal daily consumption during moderate weather was about 92,000,000 gals., or 120 gals. per capita.

Efforts to Lower Winter Maximum

Efforts to stop the waste of water during periods of cold weather by night inspections and by shutting off the water at the curb-box, without notice, at all places where water was found running after midnight, were more productive of trouble than of saving water. Practically all offenders indignantly denied wasting water, and many were not only willing to make affidavits to that effect, but also offered character witnesses to testify to their veracity. Besides, by the time a night inspection force was properly organized and broken in to the work, the cold spell would come to an end, and the practice of letting the water run was stopped. Thus, before the expected good results could be obtained, the necessity for night inspection ceased to exist, and when the next spell of severe weather came along, the people, who notoriously have short memories, resumed their old habits of opening their faucets to protect their plumbing.

Efforts to Lower Summer Maximum

The same results in effect attended all efforts to punish offenders who wantonly wasted water through hose connections in summer. The same violent denials and protests brought an avalanche of trouble to department headquarters, and the right to use an unlimited quantity of water for the purposes of health, cleanliness, and for beautifying the city in keeping up the lawns and green spots, was vehemently upheld by some of the local newspapers. The water division was coolly advised to buy more pumps and enlarge their mains, as though that were a mere matter of minor detail that could be arranged for at an hour's notice.

Meterage Only Way to Lower Consumption

Such experiences as these are common to all water works engineers and managers—and lead to the conclusion that no logic can convince the unthinking public that it is more economical voluntarily to restrict themselves to a temperate use of water, even though their current bills are not reduced, than to indulge in reckless waste, which must later be directly or indirectly expensive to them. The only way to bring home to them in a way which they can feel and understand the fact that it costs money to supply water, is to sell them water by measurement, so that he who wastes, pays.

St. Louis' Attitude on Meters

When the writer, in 1911, proposed the general metering of the city, by installing 17,500 meters each year for five years, the department to furnish and install them without cost to the individual, it raised such a storm of protest from all quarters that one would imagine that it was contemplated to deprive them of one of the sacred rights assured by the Constitution of the United States.

It was in vain that figures were submitted, showing that the saving in expenditures for increasing the capacity of the works would many times pay for the cost of meters, and that the capacity of the present works would be enabled to supply the city at least ten years longer. No one questioned the accuracy of these statements, but the majority of the people and all the newspapers continued their vociferous objections to meters, facts or no facts. Since that date the opposition has moderated to some extent, but it is still evident that the time has not arrived for an adoption of the policy of universal metering.

During the seven years from 1911 to 1918, there has been expended over $4,500,000 in carrying out a general plan to bring the existing system to the utmost capacity possible. To complete the entire system as originally contemplated, a further expenditure of over $2,000,000 will be required. It is estimated that the city can be supplied from these works until 1926, at the present rate of increasing consumption, and under the present policy of the practically unrestricted use of water by flat rate consumers.

What Metering Would Mean to St. Louis

Should the city agree to the general policy of universal metering, and provide for the installation of not less than 25,000 meters annually, at the same time enforcing reasonable restrictions for flat rate consumers during the period of changing over, it is certain that the present water works would furnish an ample supply at least until 1936.

It seems practically impossible to convince the public and municipal officers (who generally take their cue from public sentiment) of the wisdom of looking well ahead, especially as to the quality and quantity of water supply.

Most cities have at one time or another gone through the experience of having been rudely aroused from their indifference and inattention to the gradually increasing inadequacy of the water supply by its sudden scarcity or total failure. In such cases they are amazed to realize how long they have been trusting to good fortune without meeting disaster.

Then often follows unwise expenditures on hurried plans for relief from a situation that could never have arisen under proper management.

The capable and conscientious engineer or superintendent of a water works always endeavors to plan and provide for the future consumption of his community in ample time to prevent any serious shortage of water. Among the records of most of the larger water works will probably be found reports, more or less elaborate, covering local conditions, estimating future demands and proposing extensions and improvements sufficient to provide a generous water supply for years to come. These reports, no matter how pertinent to the case, or how thoroughly the conditions have been studied and reviewed, scarcely excite more than a passing comment from the press, and are then filed with the rest of the accumulated documents recording futile human endeavor.

DRAINAGE AND IRRIGATION

Features of Overhead Irrigation Systems in Small Gardens Within Reach of City Water Works Plants

By W. H. Coles, President of the Skinner Irrigation Company, Troy, Ohio

The importance of overhead irrigation has been recognized for a number of years. However, it has been only within the last few years that its relation to small gardens within the reach of municipal water works plants has come to be appreciated. This is now commanding the attention of power companies and of companies who are selling water. Its development within the next five years promises to be one of the most productive sources of income, both to the service companies and to their engineers. The story of the development of overhead irrigation provides a background which emphasizes its possibilities as linked with the future of water service companies.

Origin of Overhead Methods

Some ten years ago the overhead methods of watering first came into prominence. Systems were simultaneously developed by a large florist in Chicago, by Mr. Skinner in Ohio and also by a grower in Florida. A recent U. S. Department of Agriculture bulletin, No. 495, issued on spray irrigation, says that the development of this stationary overhead spray system marked the beginning of rapid progress in spray irrigation for commercial crops.

It was soon found that these systems were conflicting and that each possessed merit and they were united some six or seven years ago into what is known as the Skinner System of irrigation.

Elements of an Installation

If the reader were to notice, he would find in practically every vegetable growing center in the United States numerous fields equipped with long pipes, fifty feet apart, parallel to each other and parallel to the ground. These pipes are fitted with nozzles inserted every 3 feet, the nozzles being placed in a row. A series of parallel streams from each pipe is the result. These streams cover a strip from 6 to 10 ft. in width and the full length of the pipe. A space 50 ft. in width is watered by turning the line occasionally on its axis. The sprays are of such a size and the nozzles of such a construction as to conform to the principles of watering which secure the most successful results. The system is exceedingly simple. It is practically fool-proof and has been accepted as indispensable in almost every vegetable growing center throughout this country and in many other parts of the world.

Results Obtained

Remarkable results have been obtained from the use of this overhead irrigation. In the official organ of the Chamber of Commerce of the State of New Jersey, Volume 4, No. 8, there was an article by C. F. Seabrook, who has 190 acres of this system and operates one of the most modern vegetable growing farms in this country. He gives the following results from the use of the Skinner System:

Six hundred and forty bushels of potatoes were grown under the Skinner System of Irrigation, whereas our average without irrigation was about 175 bushels per acre.

Beets for the cannery with tops yield about 32 tons per acre under irrigation. Without irrigation, we produced one-tenth of this amount. Celery under irrigation yields 600

crates to the acre, as compared with 200 crates to the unirrigated acre. Irrigation has increased the onion yield to an average of 1,200 bushels to the acre, as compared with 300 bushels to the unirrigated acre. Lettuce is doubled by irrigation. The average strawberry yield through the United States is 2,000 quarts to the acre. The average yield under our irrigation system is from 8,500 to 10,000 quarts to the acre. Considering both the quality and quantity, the yield from an unirrigated acre as compared with the yield of an irrigated acre, the ratio represented is about one to five.

Automatic Operation

From these hand-operated systems more highly perfected equipment was developed. Devices are installed whereby the lines are oscillated automatically by water power and in unison, this being done in blocks of one acre, two acres or ten acres operated as a unit. From the simple hand-operated lines to the more complete and highly perfected automatic irrigation systems, this method of watering is adapted to every condition and to every need. The most highly perfected equipment provides for the first time a means whereby a garden or a field may be watered automatically, uniformly and correctly.

Profitable Relation Between Public Water Supply Works and Overhead Irrigation for Gardens

A great many power companies have interested themselves in the spread of this overhead irrigation. They work with growers, supplying power for pumping and in many localities the relation is not only very intimate but profitable for both the company and the grower. Some companies equip land and sell it out on terms, supplying the irrigation system and selling power or water as the case may be.

The results which were so clearly evident from this method of watering soon began to appeal to the small garden owner, who desired in a minor way the benefits which the commercial growers were so clearly demonstrating. The manufacturers of the Skinner System recognized this demand, developed and put on the market sectional sprinkling lines, which are sold by the foot. They are so designed as to go together automatically, and a careless grower cannot put them together in any but the correct manner. The war garden enthusiasm of last year emphasized the fact that growing is an art and that gardens which were not properly handled were unproductive. The owners began to appreciate the burden of standing with a hose and supplying their gardens with moisture.

As a result, the interest in irrigation systems for these small gardens has very considerably increased. The water works companies are recognizing this interest and are equipping themselves to handle the demand. The engineers and experts with these companies are informing themeslves of the requirements of this new line of work, and in many cases they have not only been of service to the companies with which they are associated, but they also have been called in consultation in the erection of irrigation sytsems by commercial growers on a larger scale, even though they be out of the tation in the erection of irrigation systems by commercial

The writer of this article would very emphatically deny the charge that he is an old man, but he can remember in the little town in which he lives the time when the use of a public water supply was somewhat of a rarity. It was the occasional man who had the water works piped into his house. It is now a rarity to find a residence which is not connected to the water works system. In the early days little attempt was made to keep the lawn green. The watering of the street and the watering of a few flower beds was the full use to which the water was put. Now a burned-up lawn in any summer is considered a sign of shiftlessness or indifference. The same has been true of the use of water in bath rooms, as all engineers know.

Use of Public Water Supply for Irrigation Purposes in Its Infancy

Comparatively few engineers, however, recognize that the new use of water is in its infancy. In Los Angeles, Cal., there are more than one hundred acres of the parks watered by this stationary system of irrigation, and every modern residence has some means of keeping its lawn green. The average reader of this article will be surprised to find how many similar installations exist in the eastern half of the United States, many of them running into thousands of dollars in cost. The back yard gardens of even humble owners are being equipped more and more with a permanent stationary system of watering, which eliminates the drudgery and produces full and luxurious crops.

This use of water is pressing itself on the water service companies. Not only will they find in it a profitable source of revenue, but they will soon discover that they are subject to just criticism if they do not prepare themselves to meet and to serve this demand. Within the next few years the remarkable development of this overhead watering in the commercial industry will be repeated in those lines of growing which are within the reach and which furnish an unanticipated use of water which is not as yet fully recognized.

WATER PURIFICATION AND SEWAGE TREATMENT

Some Characteristic Design Features of the Northeast Sewage Treatment Works at Philadelphia

By W. L. Stevenson, Assistant Engineer in Charge, Sewage Disposal Division, Bureau of Surveys, Philadelphia, Pa.

Work is now in progress toward the construction of 32 Imhoff tanks and their appurtenant sludge drying beds for the treatment of sewage to be collected by the intercepting sewers of the Frankford Creek drainage area in the city of Philadelphia.

This work constitutes the first step toward carrying out the comprehensive plan for the collection, treatment and disposal of the sewage of Philadelphia, as recommended in the Report of the Bureau of Surveys issued in 1915.

The present tank installation is designed to care for the sewage of 300,000 people, amounting to 60,000,000 gals. a day average flow at 3 hours' retention. It will form an integral part of the complete Northeast Works as designed for estimated conditions in the year 1950.

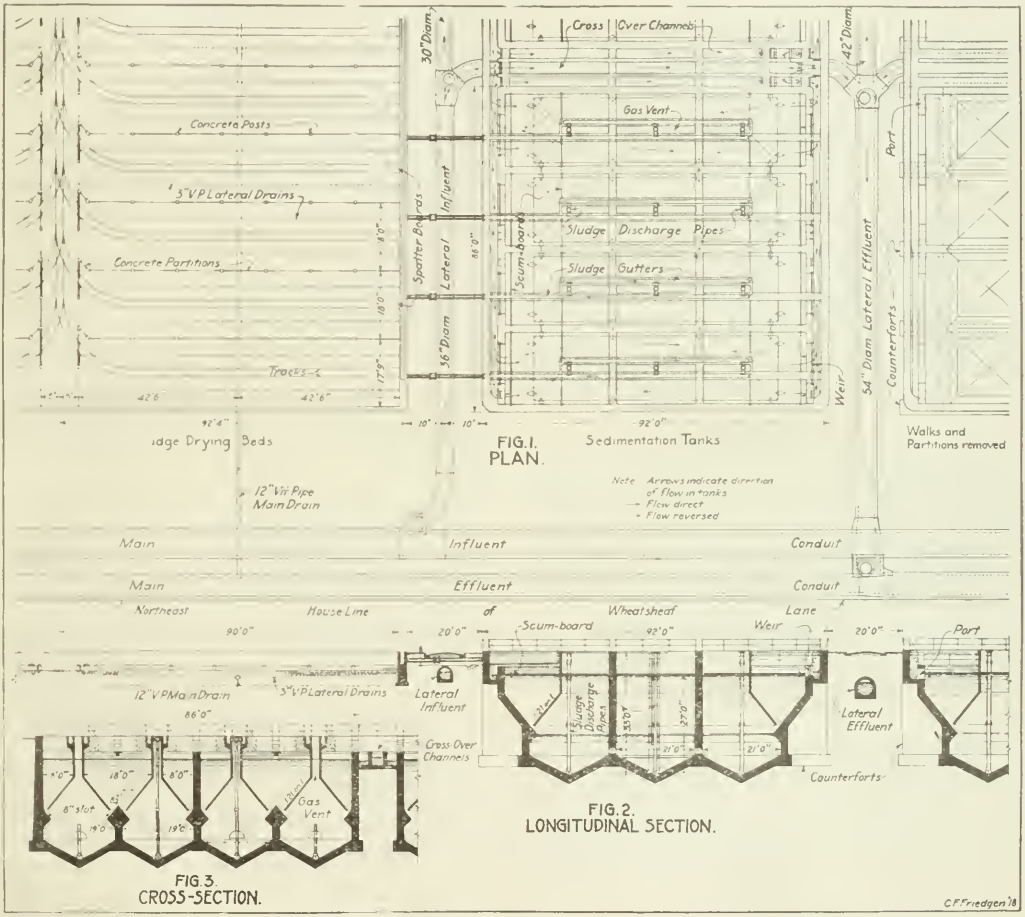
The Settling Tanks

The tanks are arranged in 4 batteries of 8 tanks each, beside which are sludge drying beds of the same overall length, divided into 20 units for the sake of elasticity in operation. The tanks are of rectangular, horizontal flow type, constructed of reinforced concrete, each 40 ft. wide, 80 ft. long and 27 ft. from the surface of the water to the bottom of the sludge hoppers, of which there are six in each tank.

From a main influent conduit, laterals will convey the crude sewage to cross-over channels at the middle of each four tanks of a battery in order to provide for reversal of flow. The tanks are entirely symmetrical, so that either end may become the inlet. From the cross-over channels the sewage will be conveyed to the tanks by open channels, which

Scumboards are provided 18 ins. and 15 ft. 6 ins. from each end of the tanks.

The sedimentation compartment is separated from the sludge digestion compartment by reinforced concrete partitions with slopes of 1.2 on 1, making slots 8 ins. wide with $8\frac{3}{8}$ ins. overlap from projections on the side and end walls.



SOME DESIGN DETAILS OF THE NORTHEAST SEWAGE TREATMENT WORKS IN PHILADELPHIA, PA.

decrease in width from 24 ins. to 15 ins., so as to maintain proper velocities as the quantity of sewage flowing in them decreases.

Tank Details

The ends of the tanks are provided with two adjustable metal weirs, each 10 ft. long, and also with two ports, each 24 ins. wide, equipped with metal sliding gates to regulate their opening. At the inlet end the ports will be open from the bottom of the channel, but at the outlet end they will be closed. Sewage will therefore be admittd to the tanks over the weirs to carry surface materials and under the ports to admit to the tank the heavier solids carried along the inlet channel near or on the bottom. By these means, it is expected to prevent any deposits in the inlet channels from carrying crude sewage.

In each tank above the sloping partitions there are two gas vents, each 51 ft. long and 24 ins. wide.

Lifting Sludge with Compressed Air

The general elevation of the site of these works is at elevation +10 and the water surface in the tanks is to be +4. In order to avoid the impression of the finished works being depressed, it was decided to carry the side walls and gas vents to elevation +10. This decision, combined with the fact that a gravity flow of sludge from the tanks would have placed the sludge beds at such a low elevation that ground water would have prevented free draining, made it desirable that the sludge beds be placed at an elevation of about +4, which requires that the sludge must be mechanically raised from the hoppers.

To carry out this policy a vertical sludge pipe is provided

for each hopper. Its upper end is a cross provided with valves at the sides and a cap at the top.

Compressed air will be introduced into the sludge pipe to raise the sludge by the principle of the air-lift pump. Water pipes will supply rinsing water in the bottoms of the hoppers and also at the top of the sludge pipe so as to fill it completely with clean water after sludge has been drawn.

Sludge Gutters

The valved sides of the crosses of the sludge pipes will discharge into gutters 12 ins. wide and 18 ins. deep at the shallowest point formed in the side of the gas vent. One gutter will be graded to carry the air-lifted sludge to the sludge drying beds. The other gutter will extend only the length of the gas vent and be graded in the contrary direction.

In addition to carrying sludge to the drying beds, these gutters can be used to transfer sludge from one hopper to another and so avoid the stagnation which is antagonistic to good digestion.

Furthermore, by the use of stop planks placed on one side of the gas vent, it will be possible in case that foaming occurs to convey such floating sludge to the drying beds instead of allowing it to flow over the settling sewage, as has occurred elsewhere.

Cross walks with guard rails are provided over the tanks connected with the end and side walls and gas vents, so that the operators can reach every part of the tanks in safety and comfort.

Sludge Drying Beds

Each sludge drying bed is 18 ft. wide and 85 ft. long. They are separated by precast concrete slabs set in posts drained by two lines of 3-in. tile leading to a 12-in. main underdrain, which in turn discharges into the main effluent conduit of the works.

A 24-in. gauge industrial track is laid down the center of each bed leading to a main track between the batteries of beds. A motor-driven engine will haul the small cars to convey the air-dried sludge to a place of disposal.

The surface of the drying beds is a 2-in. layer of mortar sand resting upon layers of graded gravel increasing in size from 1-16 in. to 1½ in.

Seeding and Planting

Upon completion of the works, it is intended to plant trees, beds of shrubs and flowering plants in such a way as to make the site attractive, as has been successfully carried out at the Pennypack Creek Sewage Treatment Works, which the city has operated since 1912, and which policy has not only caused the operators to take pride in the plant, but has shown the many citizens and other visitors that a sewage treatment plant can be kept clean and be neat and attractive.

Personnel

These works were designed under the direction of Mr. George E. Datesman, Director, Department of Public Works, by the Bureau of Surveys, of which Mr. Chester E. Albright is Chief Engineer, and are being constructed under a unit price contract with a limit of $1,025,000 by the Philadelphia Subway Construction Company.

Results of the Chlorination of Public Water Supplies in Michigan

By Edward D. Rich, State Sanitary Engineer and Earl L. Waterman.

The operation of water chlorination plants in Michigan has been under general control of the State Board of Health since January 1, 1916. There are 23 municipalities and private companies in the state which use chlorination as the only treatment for public water supplies. A brief summary of the data furnished by the reports during the year ending June 30, 1917, is given below. This information is of particular value in pointing out conditions under which chlorination is successful, as well as those where its limitations have shown that it is not adaptable. It is from Engineering Bulletin No. 10 of the Michigan State Board of Health.

Alpena

The water was treated with hypochlorite from February, 1913, to October, 1915, and with liquid chlorine since. Water is obtained from Thunder Bay (Lake Huron) and is subject to frequent pollution. Monthly reports during 1916 show that the average pumpage is 2,061,000 gal. per day. Liquid chlorine is applied in amounts varying from 2 to 6 lbs. per million gallons. Organic matter in the raw water as indicated by the oxygen consumed tests is often very high. Laboratory control and careful supervision of the chlorinating plant have not sufficed to produce a safe palatable water at all times. Our information indicates that other treatment of the water is necessary.

Ann Arbor

The city has two sources of supply, deep wells and Huron River. River water was treated with hypochlorite from 1912 to June 15, 1915, when a change to liquid chlorine was made. The average pumpage at this plant is 2,800,000 gals. per day. Eight to 10 lbs. of liquid chlorine are used per million gallons of water. Laboratory tests show the presence of organic matter in considerable amounts, unusually high bacterial counts at 37° in both the raw and treated waters, and the chlorination treatment is not entirely satisfactory and points out the necessity of adopting some other method of water purification.

Battle Creek

Most of the supply comes from deep flowing wells with an auxiliary supply from Goguac Lake. Water from the lake is treated with liquid chlorine at a rate of one pound per million gallons. Hypochlorite of lime was used during the period of March, 1912, to April, 1914, when the change to liquid chlorine was made. Results of laboratory examinations of untreated and treated water seem to indicate that the chlorination is successful.

Bay City

There are two entirely separate water supply systems, East Side and West Side. The East Side supply is taken from two sources, Saginaw Bay and Saginaw River. The daily pumpage at this station averages 4,500,000 gals. Hypochlorite of lime was used for several years prior to the installation of a liquid chlorine treatment plant in April, 1916. Liquid chlorine is applied at the rates of 3 to 4 lbs. per million gallons. Results of daily laboratory tests show that the East Side water is seriously polluted; liquid chlorine treatment is not successful.

The West Side supply is drawn from Saginaw Bay. The daily pumpage from this source averages 2,300,000 gals. This water is subject to contamination to a degree which varies with wind conditions on Saginaw Bay. Liquid chlorine treatment was begun in April, 1916, the rate of application being 1 to 3 lbs per million gallons. Laboratory examinations indicate that this treatment cannot meet the changing conditions of the raw water in such a way as to render the water always safe and fit for domestic purposes. Preliminary plans for a filtration plant at Bay City have been prepared.

Detroit

The municipal supply is taken from the upper part of the Detroit River. It was treated with hypochlorite from April, 1913, to March, 1916, and with liquid chlorine since January, 1916. The daily pumpage averages 130,000,000 gals. The water is treated with 1.5 to 3 lbs. of liquid chlorine per million gallons. Laboratory examinations show that chlorination produces good results. This plant has excellent supervision which undoubtedly contributes largely to its successful operation.

East Grand Rapids

The municipal water supply is taken from Reed's Lake, the average daily amount pumped during the last ten months of 1916 was 63,400 gals. Liquid chlorine has been used since June, 1915—the average amount used during 1916 was 4.96 lbs. per million gallons. Weekly tests on both the raw and treated water show a rather high organic content, low bacterial counts per cubic centimeter, and only rare instances of the presence of B. Coli. Chlorination of the public water supply in East Grand Rapids results in furnishing to the consumers a safe, potable water.

Gladstone

The municipal water supply is taken from Little Bay de Noc (Lake Michigan). Hypochlorite treatment has been used since December, 1913. The average daily pumpage during 1916 was 342,000 gals. Hypochlorite of lime was used in amounts varying from 12 to 25 lbs. per million gallons. The solution is pumped into the raw water through small proportional pumps attached to the main pumping units. This insures a constant rate of dose, but does not allow much flexibility in the amount of the solution to be applied. It is interesting to note that owing to the difficulty in securing bleach, no treatment was applied between January 25, and April 28, 1916. Tests made at the State Laboratory at Houghton, indicate that closer supervision and control is necessary to insure the successful operation of this chlorination plant.

Highland Park

The supply from Lake St. Clair has been treated with liquid chlorine since June, 1915. The average daily quantity of water pumped during 1916 was 7,000,000 gals. Liquid chlorine was applied at a rate of 1 to 3 lbs. per million gallons. Tests show that this source of water supply is subject to contamination particularly during the summer months, and that at this period the chlorination did not produce a uniformly satisfactory drinking water. Plans for a filtration plant are being made.

Ludington

The municipal water supply is taken from Lake Michigan, and is treated with hypochlorite of lime. This treatment was begun in March, 1912. The 1916 monthly reports show that the average pumpage was 1,250,000 gals. and that the hypochlorite was applied at an average rate of 6 lbs. per million gallons. Laboratory tests were made irregularly until December 1st. when daily analyses of the raw and treated water were started. The results of the analyses made during December show that the chlorination of the water resulted in a 98 per cent reduction in the number of organisms growing at 37°C. B. Coli was not present in either the raw or treated waters.

Marine City

Water for the municipal supply is taken from the St. Clair River, the average pumpage being about 1,250,000 gals. Hypochlorite treatment was begun in December, 1913. During 1916, the rate of application of the bleach was about 6 lbs. per million gallons. No laboratory tests are available on which to base an opinion as to the efficiency of the treatment.

Menominee

The supply is taken from Green Bay. Hypochlorite treatment was used from March, 1910, to October, 1916, and liquid chlorine since. The average daily pumpage is approximately one million gallons. Laboratory reports show that this source of supply is subject to contamination. A filtration plant has just been completed. Liquid chlorine will be used as a supplementary treatment by the new plant.

Monroe

This plant is owned by the Monroe Water Co., and the supply comes from Lake Erie. The average daily pumpage is 1,200,000 gals. Liquid chlorine treatment is used at rates varying from 3 to 8 lbs. per million gallons. The reports for 1916 show that this water does not readily yield to chlorine treatment. There were 66 bacteriological examinations of the treated water during 1916; 31 tests or 47 per cent show B. Coli present in 10 c. c. quantities of water; 24 tests or 36 per cent show B. Coli in 1 c. c. quantities of the treated water. We are informed that there are many complaints about the tastes and odors in the treated water. The 1916 reports show that chlorination is not a success and point to the necessity of adopting other methods of water purification for this plant.

Negaunee

The municipal water supply is taken from Teal Lake and has been treated with hypochlorite since January, 1911. For 1916, the average daily pumpage was 1,300,000 gals. and the hypochlorite treatment was at a rate of 1 to 4 lbs. per million gallons. Laboratory tests are made regularly and indicate that chlorination of Teal Lake water is an effective method of treatment.

Port Huron

The municipal supply is pumped from St. Clair River and treated with hypochlorite of lime at an average rate of 7½ lbs. per million gallons. The average pumpage during 1916 was 9,500,000 gals. per day. The hypochlorite solution is fed through proportional pumps. A municipal laboratory has been installed but was not ready until Dec. 1, 1916. Tests made during December show that the water was low in organic matter and that the chlorination treatment was successful from a bacteriological standpoint. Liquid chlorine is to be substituted for the hypochlorite method.

South Haven

The municipal supply is taken from Lake Michigan. The Black River empties into the lake just north of the water works plant and under certain conditions the river water undoubtedly carries pollution out to the water intake. The continued prevalence of typhoid fever in South Haven led to the adoption of chlorination treatment for the water supply in April, 1912. A remarkable reduction in the number of cases of typhoid fever has resulted.

Excellent laboratory control and careful supervision of the chlorination plant have given very good results. There are a few times during the year when contamination reaches the water intake—on these occasions the production of a satisfactory effluent by chlorination is very difficult.

St. Clair

The municipal supply is taken from St. Clair River. Hypochlorite of lime treatment has been used since May, 1913. The average daily pumpage during 1916 was 738,800 gals. and the application of hypochlorite was at rates of 5 to 8 lbs. per million gallons. There were no regular laboratory tests during 1916 and we have no data on which to base an opinion as to the efficiency of the chlorination treatment at St. Clair.

Wyandotte

The municipal water supply pumped from the Detroit River below the city and treated with hypochlorite of lime. The average daily pumpage during 1916 was 1,866,500 gals. Hypochlorite is applied at rates varying from 15 to 20 lbs. per million gallons. Daily laboratory examinations of both the raw and treated water have been made since July 10, 1916. The results of these tests are most conclusive in pointing out the fact that the Wyandotte water supply cannot be rendered safe and palatable by the process of chlorination. We are informed that very frequently the odor and taste in the treated water are so strong that the water is wholly unfit for any domestic use, furthermore, the water is unsafe from a bacterial standpoint, approximately 99 per cent of the time.

St. Joseph

The municipal water supply is pumped from Lake Michigan. Hypochlorite treatment, begun in July, 1912, was changed to liquid chlorine in April, 1916. The average daily pumpage for 1916 was 778,300 gals. Since the installation of a liquid chlorine machine, liquid chlorine has been used at an average

rate of 1.5 lbs. per million gallons. A municipal laboratory was installed in April, 1916, and since that time complete reports of daily tests of the water have been submitted for the St. Joseph city water.

Traverse City

The municipal supply is pumped from Grand Traverse Bay (Lake Michigan). Hypochlorite treatment was begun in July, 1912, and continued irregularly until May, 1916, when a liquid chlorine machine was installed. A municipal laboratory is provided and daily tests were made during the last half of the year. The results show that the chlorination treatment is satisfactory.

From Workers in Field and Office

Facilitating Motor Freight Haulage

The Editor of Municipal Engineering:

Sir—"From Detroit to Berlin," an unusually suggestive sign it was, stretched across one of the army trucks which recently made the trip from the factory in Detroit to the point of embarkation.

The army recognizes the dire necessity of easily passable, permanent roads, which are becoming as important a medium of transportation as the railroad—the motor truck as the locomotive. France has come to recognize the difference between temporary roads and the type of road necessary to withstand the constant pounding jar of heavily laden ammunition trucks and trailers.

Reports received from official British and French sources declare that the wear and tear on roads to the front is ten times as great as the traffic on Fifth avenue, New York.

THE HELTZEL LIGHTNING LOADER SKIP AS OPERATED IN CONJUNCTION WITH MOTOR TRUCKS.

Impediments of all kinds have combined to curtail the improvement of highways throughout the United States. It is impossible to recognize how any one can advocate the cessation of road construction in this country at this time. Roads—more roads and better roads—are a war necessity.

Since the United States entered the war, however, motor truck transportation on highways has remarkably developed, due to the following reasons: The marked increase in tonnage and bulk of freight shipments; the lack of railroad equipment efficiently to handle freight; the inadequacy of railroad terminal facilities, together with the United States government prlority orders.

Considering war conditions, the haulage of freight by motor trucks over highways has become commendatory in order to relieve the congestion of terminals. To relieve the railroads many classes of freight could be transferred to motor trucks more efficiently, helping to relieve congestion and the shortage of cars.

It is evident that it will be necessary for state highway departments, counties, municipalities and contractors to use motor trucks under all practical conditions for the transportation of highway materials and machinery, and that highways of inter and intrastate transportation must be improved, if commercial and agricultural activities necessary to the conduct of the war be maintained.

A program of some kind should be outlined for the improvement of such arteries of transportation as are found to be most essential, so that construction may be started at once and carried on expeditiously at a minimum cost.

The efficiency of the motor truck itself should not be lost sight of. Cost data and comparative records are available, and progressive hauling concerns anticipating entrance into this new field of operation should thoroughly acquaint themselves with every facility and labor-saving device in order to maintain operation at the maximum.

THE HELTZEL LIGHTNING LOADER SKIP AS OPERATED WITH INDUTRIAL RAILWAY.

Car unloaders such as the Heltzel are widely used by hundreds of the largest road, pavement and highway builders of this country. These loaders have, in many cases, increased the hauling efficiency to the extent of 20 per cent. They are quickly installed on an open gondola car and keep the trucks constantly on the move by minimizing the delay of loading to a mere fraction of time. At the same time, the men in the car are kept continually shoveling; thus the efficient co-ordination of the working and operating force with the hauling force tends to make a smooth and efficient organization.

Questionnaires forwarded to many users of these loaders were returned, showing unprecedented results in increasing the daily tonnage handled and decreasing operating expense.

Every means at the contractor's command should be brought into play effectively to maintain the high standard of economic operation as necessitated by the present emergency.

M. C. BOYD, Manager of Sales,
Warren, O. The Heltzel Steel Form and Iron Co.

Route Your Freight Via Motor Truck

Editor MUNICIPAL ENGINEERING:

Sir—The only route at the present time that is free from embargoes, traffic congestion and delays is the motor truck route. The highways which we have been building in this country for the past few years are now proving one of the very best investments that we could have made.

These modern permanent highways now open up the only logical solution to the transportation tie-up. The motor truck of today is capable of transporting freight on short hauls, in vast quantities, at a reasonable rate and with much better dispatch than the railroads.

Motor truck freighting has the added advantage of eliminating at least two extra handlings of freight, which are always costly and the reason for undue delays.

The United States Motor Truck Company has consistently urged its various distributors and district sales managers to bring this to the attention of firms with transportation difficulties, and has been very successful in interesting large manufacturers to install a transportation system not only for their own protection, but for the relief of the railroads.

U. S. motor trucks are in operation hauling freight between near-by cities in all parts of this country. The rate charged is usually slightly less than express rates, although in some cases it has been possible to handle the business on regular freight rates and make a handsome profit.

E. S. LEE, JR., Manager of Sales,
Cincinnati, Ohio. The United States Motor Truck Co.

Resurfacing Existing Paved Streets

Editor of MUNICIPAL ENGINEERING:

Sir—The advent of the automobile and its increasingly general use, and particularly the introduction and extending use of the motor-driven truck for all sorts of delivery and general transportation service is producing profound changes in the character and design of the highway surfaces of the streets and roadways everywhere.

Not so many years ago during the horse-drawn vehicle days the principal demands made on a street or roadway surface were a reasonably smooth surface, as durable as possible, which could be built at a low initial cost.

To meet these demands many thousands of miles of streets and roadways were built of such materials which would best meet these requirements and as a result of this policy one can find examples of these types of structures scattered far and wide. The change in the fundamental requirements made of a paved surface can be best described as an insistent demand for greater smoothness and noiselessness, these demands overshadowing to some extent the desire for low first cost.

This demand has been met in some cases, at least, by an effort to surface over the existing pavements with a wearing surface which will meet these expectations for extreme smoothness and noiselessness and as a result there have appeared numerous types of paving with asphalt, asphaltic concrete, cement concrete and others of like nature applied to and covering the existing constructions.

As a general proposition such a resurfacing scheme works out quite well; the old pavements, even if not provided with the more modern concrete foundation, lend themselves very well to this treatment and consquently it is to be expected that there will be more and more of this work done.

Generally speaking, excellent service is being given by streets which are covered with a wearing coat of about 1½ ins. of asphalt surface, or similar material, placed on a binder coat of 1½ ins., which is placed directly on the existing street surface; such binder and wearing coat extending usually from curb to curb.

The cost of such a type of resurfacing compares very favorably with that of an entire new construction; with the present day very high scale of prices for all the elements of a new pavement and with the national government demanding the greatest economy in all directions, is not the resurfacing of many of our existing streets the ideal method of providing street surfaces adapted to modern needs and yet complying to a very large degree with the government's demands?

It would seem so and it is safe to say that the era of smooth resurfaced streets is just about beginning and that their use will become more and more general. Very truly yours,

Ohio City Engineer.

Motor Truck Used as Water Sprinkler, Road Oiler, Fire Extinguisher, Refuse Wagon, and for Piling and Hauling Snow

The Editor of MUNICIPAL ENGINEERING:

Sir—The motor truck illustrated herewith is used at various times as a water sprinkler, a road oiler, a fire extinguisher, a refuse collector, and when equipped with a plow is used for piling and hauling snow.

The truck is a Peerless. In summer a tank body is put on and it is used at different times either as a water sprinkler or to spread road oil. It has a pump that allows it to throw a stream some distance, so that it can extinguish small brush fires along the road. When the watering and oiling season is over, a dump body is installed that will carry 100 barrels of

PEERLESS TRUCK EQUIPPED WITH MOTOR PLOW FOR PILING AND HAULING SNOW, BOSTON, MASS.

ashes or refuse. In winter this body is used to remove snow. The plowing attachment was furnished by the Good Roads Machinery Company, of Boston. It can be put on or taken off in a very few moments.

JOSEPH J. NORTON, Supervisor
Boston, Mass. Highway Division, Public Works. Dept.

Unbroken Bulk Big Feature in Transporting Freight by Motor Trucks

Editor Municipal Engineering:

Sir — Probably the greatest advantage in transporting freight by motor trucks in intercity and interstate haulage is the feature of unbroken bulk. As every one knows, time and labor in trans-shipping less-than-carload freight are costly items in moving any product. Direct delivery from shipper to consumer is possible only by the use of motor trucks. The flexibility of the motor truck is such that it is not restricted to any fixed road. It takes the shortest cut between points and circumvents any obstruction, such as going around a blocked road, detouring to avoid a damaged bridge, or selecting the best highways.

There really is no comparison between the efficiency of motor haulage and railroad haulage on less-than-carload shipments. The railways simply cannot do the work efficiently and on time. The substitution of elastic motor transportation overcomes all drawbacks imposed by the railroads. With the future development of highways, motor transportation between points at great distances will become an established fact. Already, motor trucks are venturing into new districts. Two years ago a trip between New York and Philadelphia, by a motor truck, was a much-heralded event.

Today the motor transportation idea is becoming bolder. Columbus ventured forth on an uncharted sea with only his courage to sustain him. In the present state of country highways, the motor truckman must have an unusual degree of courage to attempt driving between certain of our cities, but we have the advantage of knowing the definiteness of our destination and get there somehow, even with the fearful handicap of our highways. If these grave difficulties of road transportation are now being surmounted by the intrepid interstate trucker, and time and money is being saved, what will be the rewards when Congress awakens to the need of practical military highways, and develops a chain of such highways between all of our principal cities and towns?

We are at the beginning of an epoch in motor transportation which promises to become one of the actual wonders of the world. Very truly yours,

D. O. Skinner.

Advertising Manager International Motor Co.

New York.

Long-Distance Motor Trucking

Editor of Municipal Engineering:

Sir—The operation of motor trucks in city haulage work is fairly well understood and even in the most severe winter weather proceeds with but slight interruption. The freight congestion, consequential to the state of war into which we have been drawn, has brought about demands for intercity haulage never before considered and which in ordinary times would probably have required years to approximate.

Motor Trucks to Save Situation

Goods must positively be moved, supplies delivered regardless of season, road or weather conditions—in fact, the word impossible has been eliminated from the transportation dictionary and as the common carriers—electric and steam lines—either can not or will not meet the unprecedented conditions existing practically all eyes are directed upon the motor truck as representing the salvation of the situation.

Probably never in the history of the motor truck industry has such an opportunity arisen to prove the value of its product. To the American truck manufacturer, who unlike his French, British, Italian and German contemporary who has enjoyed for years the recognition and support of his government, the time at last seems to have arrived when his standing and value in the commercial world will be appreciated.

Intercity Trucking a New Problem

With the exception of Massachusetts, Rhode Island, Connecticut, parts of New York, New Jersey, Pennsylvania and southern California, the subject of intercity transportation is comparatively a new problem and one which will have to be studied carefully before success may be obtained. All trucks are not properly designed or constructed to prove profitable or dependable investments for long and exacting road travel and the driver problem presents a consideration worthy of the closest study.

Better Roads Paramount Necessity

The roads of our country are unfortunately not generally constructed to meet the requirements of motor transportation and no loss of time should be allowed to elapse before universal action is taken toward their betterment or entire reconstruction. Tremendous sums of money will be required for such work, but inasmuch as every man, woman and child will be the profiter thereby any outlay intelligently and honestly conducted is justified by the conditions and grim necessities we all now face.

Limitations of Steam Transportation

Steam and electric roads in spite of the engineering skill exercised in their layout and construction are, during the winter months, often rendered absolutely inoperative by snow, and it is surprising how even a slight fall will tie up a division or entire system. Dependent as it is upon a metal to metal contact between driving wheels and rails, a locomotive is capable of negotiating only the slightest of grades, judged from a motor truck standpoint, and the snow or ice covering which may put a train schedule completely out of business hardly affects the truck at all.

Elasticity of Motor Transportation

Having a permanent right of way over which it must travel if at all, the railroad lacks the elasticity of motor transportation, which, in case of one route being blocked or flooded, can generally select another. Time may and often is lost through such a cause, but the all-important point is that the goods are delivered. Practically all of our Eastern roads are now so congested, or said to be congested, with freight impossible to deliver, as to be embargoed against the shipment of everything but perishable foodstuff—a condition impossible of arising in connection with motor transportation.

Trucks as Fast as Freight Trains

Taking into consideration the average time required during normal conditions and the delay in carrying freight to and from the railroad, a freight shipment from Detroit to New York or Philadelphia will require about seven days. Actual experience during the worst weather of the present winter conclusively shows that motor trucks transport their loads in the same time or even less. No claim is made that in such a trip the cost per ton will be as low as that of the railroad even with the cartage charges at each end of the line included, but more often than not the increased expense incurred is justified by the sureness of delivery, express time and less liability of damage.

Points to Consider in Intercity and Interstate Trucking

As mentioned in the first part of this letter, there are a number of points for serious consideration in connection with intercity and long-distance haulage which are not so important in general trucking work.

The routes, schedule, supply and service stations or bases should be carefully laid out by *competent* motor transportation men—work beyond the knowledge or capabilities of the average motor truck representative. A very careful selection of machines should be made, as in spite of what dealers or even manufacturers may say, every truck is not suited to this trying and exacting service.

Having arranged the foregoing, every precaution and pro-

vision should be made to the end that no matter what kind of weather or road conditions are encountered during the winter season, the trucks and men may cope successfully with them.

Every machine should at least carry a helper or extra man besides the driver. Each truck should be properly fitted with a cab with curtains and windshield affording complete protection to the men. Care should be exercised to see that there are no gas leaks in tank, piping or exhaust manifold as defects of this character have some times proved fatal.

Motor Supplies to Carry

A Pyrene or other approved type of fire extinguisher should be conveniently carried and the tool kit, jacks, etc., maintained in first-class working order. An electric or Prest-O-Lite gas head or spotlight should be mounted convenient to the driver or helper and a few extra parts such as valves, valve springs, plugs, etc., carried in an extra case for emergency repairs. One of a number of compact forms of block and falls with wire cable will often prove of great value and can be carried with the extra parts. A bucket of sand, shovel, extra cans of gasoline and oil and a few burlap bags take but little space and are worth a fortune often times.

Traction Chains

During a snow fall, all trucks traveling a route should be fitted with a snowplow of adjustable type in order to maintain the roads in running condition. Last and by far the most important item is that of traction chains. For country road work these should be much larger or heavier than for city use and no less than seven or eight applied to *each* of the driving wheels. They should be so designed as to be instantly attachable or detachable and the driver compelled to see that they are used only when necessary. A lighter set may also be carried for service in city delivery work, where the hard pavement would prove the others undesirable. Too much importance can not be laid upon the fitting of each wheel with a traction chain at least every 15 or 17 ins. around its circumference.

The idiotic practice of applying one or a few chains to one wheel only positively guarantees a stalled truck, due both to the action of the differential gears as well as insufficient traction of a continuous nature throughout the complete revolution of the wheel. The average truck wheel diameter is 36 ins., a circumference of 113 ins.—it should be easy to understand that one chain having passed the point of road contact will permit the wheel to gain so much momentum before it again strikes the ground as to offer little or no obstruction in its passage. For this reason sufficient numbers of chains should be applied to offer a continuous series of gripping actions. While such grips will reduce the pulling power of the motor, there is always sufficient reserve, particularly through resort to lower gear ratios, to meet any condition.

The Driver's Winter Clothes

Of equal importance to the proper equipment of the machine is the comfort and well being of the driver; too little thought has been given to clothes in the past, not only by the employer, but by the driver as well, and as a consequence neither man nor machine has delivered their greatest efficiency during the winter weather. The general get up of the North woods lumberjack is a very good combination permitting as it does freedom of movement while providing warmth. The writer has during the last nine years used a combination consisting of quilted helmet with detachable face mask, dogskin quilted long coat with split skirt, which can be transformed into trouser legs, one or more pairs of lumberman socks worn one over the other with arctics as outside covering and as many pairs of woolen gloves as conditions require, all constitute a driving uniform which will afford plenty of warmth, protection and comfort under any condition met with even without a cab and the temperature 30 degrees below zero.

EQUIPMENT HINTS FOR LONG DISTANCE TRUCKING IN WINTER. LEFT: A FAIR EXAMPLE OF HOW WHEELS ARE, BUT SHOULD NOT BE, EQUIPPED WITH CHAINS. RIGHT: A MOTOR TRUCK DRIVER DRESSED FOR A LONG, COLD DRIVE.

Thus provided and equipped there ceases to be any question as to the feasibility or success of mechanical transport over long distances during the season when the difficulties and hardships are greatest.

Charles E. Stone,
Transportation Engineer, J. C. Wilson Company, Detroit, Mich.

Proper Relations Between Sales Engineers, Contractors and Engineers

By Arthur W. Greetham, Manager of Excavator Sales, Pawling & Harnischfeger Co., Milwaukee, Wis.

My view of the proper relations between Sales Engineers, Contractors and Engineers is that of co-operation.

I believe that Engineers can and do, a great many times, offer suggestions to the contractor on the class of equipment necessary to handle the work. The engineer should also be willing to furnish sales engineers details of the work which would enable them to render the contractor valuable assistance in selecting equipment.

The contractor is the one individual to be most benefited by this co-operation, because it is only through the selection of proper equipment that he earns the most profit on the job and establishes his reputation as a contractor. The engineer is interested chiefly in the successful completion of his plans and he must know that the contractor properly equipped can best carry them out.

The sales engineer is not only interested in selling the contractor, but desires to place the proper equipment on the work thereby satisfying the contractor, furthering the prestige of his firm and equipment as well as being of maximum assistance to the engineer in carrying out his designs.

It has been my experience that the above relation works out nicely and I can endorse it as practical and beneficial to all parties concerned.

Plant Units and Lay Outs

A Rotary Concrete Surfacing Machine

The Berg rotary concrete surfacer comprises a cutting tool driven through a flexible shaft by an electric motor carried by the operator. The entire apparatus weighs 30 lbs.; the tool itself weighs 9 lbs. The cutting tool consists of a disc in which are mounted 16 hardened steel cutter wheels. The cutter wheels roll on the surface to be dressed and are so designed that their teeth remove the material by a chipping action. A special stone and grinding attachment is included as standard equipment. This attachment is interchangeable with the cutting tool and is used for grinding in a mixture of cement and sand which is swabbed on the surface after the board marks and projections have been thoroughly removed by the cutting tool.

The board marks and projections are removed with the cutting tool attachment. This work should be done as soon as convenient after the forms are stripped. A mixture of 1:2 cement and white screened sand, reduced by water to the consistency of thick paint, is then swabbed on in small patches and, while still wet, rubbed in immediately with the stone grinding attachment. The action of the stone, which rotates at high speed, has the effect of grinding up the plastic material and forcing the finely ground mixture into the pores, removing the surplus, producing a thoroughly and permanently bonded. smooth surface that is impossible of production by hand. The resulting surface also has high moisture-resisting qualities.

When removing projections and fins only, in preparation for a float or rubbed finish, the surfacer will prepare 100 sq. ft. per hour. It will cut down the surface to one color, leaving a perfectly flat wall, at the rate of 70 ft. per hour. The aggregate may be exposed to a bush hammer finish at the rate of 60 ft. per hour. The stone grinding attachment will produce from 35 to 50 ft. of smooth surface per hour. The total cost of operating the surfacer, exclusive of labor, does not exceed $1.65 per day.

New Land Dredge of Walking Type

Contractors engaged in drainage and ditch work will be interested in the new type of land dredge manufactured by the Bay City Dredge Works. This is a walking dredge using a series of feet in place of the steel trucks and sectional track for moving the dredge ahead on the work.

NEW BAY CITY LAND DREDGE OF THE WALKING TYPE.

Four corner feet are attached permanently to the four corners of the dredge and two large movable feet are in the center, one on each side. The moveup cable passes over a set of sheaves and attaches to the upright or leg on each side above the middle foot. When the operator is ready to move up on the work he engages the clutches controlling the moveup drum and as the cable tightens up it gives a lifting motion to the entire dredge and transfers the weight of the dredge from the corner feet to the center feet. When the weight is removed from the corner feet the tension on the moveup cable causes the dredge to move forward over a set of rollers attached to the middle legs and resting under the longitudinal framework of the dredge. The dredge moves forward 5 to 10 ft. at a shift, the center feet, which temporarily carry the weight of the machine, remaining stationary. When the operator has moved forward the required distance, the tension on the moveup cable is released and the dredge settled on the corner feet. The center feet are then pulled forward until the front of same are flush with the rear end of the front feet. The feet are then in position for the next step.

This move ahead motion is quite rapid and an experienced man can move forward at the rate of 2 steps in 60 seconds. It is possible to move across open country from one piece of work to another at the rate of 500 to 1,000 ft. per hour.

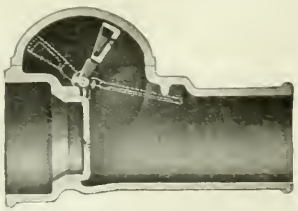
The walking dredge will work successfully over rough, marshy, soft or slippery ground. No track, skids or extra planking are required. No track men are used and labor troubles are greatly diminished. The increased speed of moving produces larger yardage and lower operating costs. This walking dredge will be found particularly desirable in drainage districts, where the yardage per station is small, where there are many laterals or where there are a series of short, detached ditches. It will be possible to move from one section of the work to another with a great deal of speed, cutting out the lost time on dead moves and proportionately increasing the monthly yardage.

This walking type of land dredge has been built for the past two years and now they are working successfully in nine different states. They are also suited for highway ditching, sand and gravel pit work, large drain tile and sewers and irrigation canals.

The Pennie Back Water and Sewer Gas Valve

The Pennie valve is for sealing the waste pipe in residences, pubilc buildings and factories so that water, vermin or sewer air can not get back into the sewer from the building. This valve has also proven successful for keeping dry the manhole of street railway, telephone, water and gas utilities.

The closure against back-flow is effected by a balanced



bronze and cast-iron disc which fits against a brass seat, the contact surfaces being machined for close fit. The operation is made absolutely positive in any position, by fastening lead in the counterweight cup if necessary to make the disc swing to the required angle. No lead is required when the installation is applied by taking off the cap and pouring into the

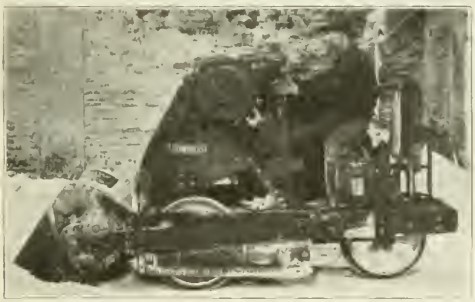
cup, which has countersunk holes in the bottom to hold the lead permanently in position.

The valve or disc need not be removed when the cup is being weighted for regulation, all that is necessary being to hold a wiping rag or flat surface under the counterboard holes to prevent escape of the lead before it hardens.

This valve, which is made by The Kennedy Valve Mfg. Co., comes in from 2 to 12-in. sizes for either standard or extra heavy soil pipe.

Power Scraper Shovel

The Brownhoist power scraper shovel is here illustrated at work in a warehouse. This machine is driven by a gasoline engine. The scraper bucket is pushed into the material to be moved and can then be raised if desired, or the material can be pushed along the surface it is resting on. The machine comes in two sizes, the smaller weighs 4 tons and has a 15 cu. ft. bucket, while the larger weighs 8 tons and has a 24 cu. ft. bucket. While this machine has been largely used in ore-handling, it can be used also in handling concreting materials.



BROWNHOIST SCRAPER SHOVEL IN USE IN A WAREHOUSE HANDLING BULK MATERIAL.

Economical Coal Storage Systems for Cities

A certain coal storage system, which has been in use for a number of years, consists of a concrete pit 300 ft. long, 100 ft. wide and 28 ft. deep. The bottom of the pit is 18 ft. below ground level and provision is made to flood the coal up to the ground level. It has a capacity of 30,000 tons, with 13,000 under water. A Brownhoist locomotive crane operates on a trestle running through the middle of the pit and handles the coal on both sides with a 1½-ton Brownhoist coal bucket. As the coal comes in it is dumped through the bottom if received in that type car or is unloaded by the crane when necessary. When coal is needed in the power plant it is loaded by the crane into the cars, which are run into the plant.

In open yard storage systems Brownhoist locomotive cranes are also used. In one yard six of these cranes are used, and the coal is stored on both sides of the track until required in the power plant. One of these cranes will handle from 75 to 100 tons per hour when working in free coal or will unload from cars 50 to 60 tons per hour. Besides handling the coal, the crane also does switching work and any other hoisting work as required around the plant.

Reinforced Concrete Pipe with Special Locking Joint

The reinforced concrete pipe with special locking joint of Keystone manufacture, here illustrated, has been manufactured for the past three years. The pipe ranges in size from 24 ins. to 7 ft. in diameter. All the pipe is reinforced with four $1\frac{1}{4}$x$1\frac{1}{4}$-in. bars and above 18 ins with six steel bars $1\frac{1}{4}$x$1\frac{1}{4}$-in. and American triangle mesh reinforcing wire. The form is placed around the reinforcement and is then locked and filled.

Each ring of the form is in two sections, which may be easily fastened together or loosened up. A cast-iron ring fits into the top of the space between the outer and inner form, and at the bottom the opening is closed up by a similar ring. These rings are so constructed as to shape the desired notches in the ends of the pipe. The top ring is, of course, only wide enough to accomplish this purpose, and it leaves room for the mortar to enter the form. These rings also have holes for the ends of the longitudinal reinforcing, holding them in just the right position.

Sections of pipe are drawn together and locked. This is done by means of Keystone lugs and bolts. On account of the peculiar construction there is absolutely no chance for the bolts or lugs to become loosened and allow the pipe to spread. After the pipes have been locked all metal parts are covered with cement, which eliminates any chance of corrosion. This leaves a perfectly smooth surface, both on the interior and exterior of the pipe. The construction of the joints and concaves are such that one-half the concave is on top and outside and one-half on the bottom and inside. The locking of the joint prevents joint settlement.

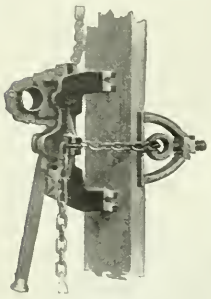
VIEW OF REINFORCED CONCRETE PIPE OF LOCKING AND SEALING TYPE.

A Chaingrip Pipe Vise with Novel Features

The Chaingrip pipe vise here illustrated is simple and portable. It fastens to any kind of horizontal or vertical support, whether round, square or flat, without the use of bolts. It locks any size pipe or conduit within its limits by a push of the lever; no previous adjustment is necessary.

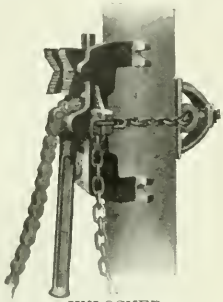
The base support of the Chaingrip is squared out in the form of an inverted V, at the sides of which are bolt lug feet, to be used only in case the vise is to be permanently bolted in one position. Hence it will conform to a round, square or flat surface. A clamp support on the opposite side of the column is a part of the Chaingrip equipment. It is a bell section shape, having a boss at the top, through which a threaded supporting eye bolt passes free. A heavy nut resting on the top of the boss, and engaging the threaded eye bolt, adjusts the tension of the chain passing through the eye of the eye bolt. The base of the clamp support is squared out in a manner similar to the vise base, in such a way that it fits the same shaped surfaces.

A heavy wrought iron chain is riveted on one side of the vise base. It passes around the supporting column, through the eye of the eye bolt in the clamp support, and thence to the other side of the vise base, a link being held securely in position in a socket. Tightening of the eye bolt nut tightens the supporting chain and holds the vise rigidly in



LOCKED

CHAINGRIP MOUNTED ON THE CORNER OF A WOOD, CONCRETE OR IRON UPRIGHT.



UNLOCKED

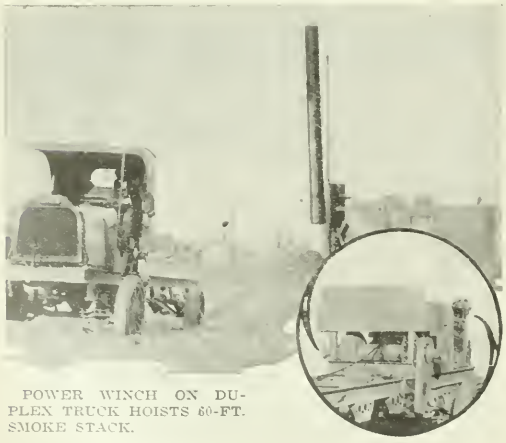
CHAINGRIP MOUNTED ON A ROUND WOOD, IRON OR CONCRETE COLUMN.

position. The Chaingrip vise locks a pipe or conduit firmly between a double set of steel pipe jaws on one side and a heavy, close-linked steel chain on the other. The locking motion is accomplished by the movement of the handle toward the vise.

Power Winch on Motor Truck Hoists 60-Foot Smoke Stack

Due to the great demand from lumber concerns, machinery houses, oil refineries and safe and machinery movers for motor trucks equipped with power windlasses, the Duplex Truck Company is now installing on its four-wheel drive truck, as special equipment, a power winch of ten tons capacity.

The power winch furnished with Duplex Trucks is operated



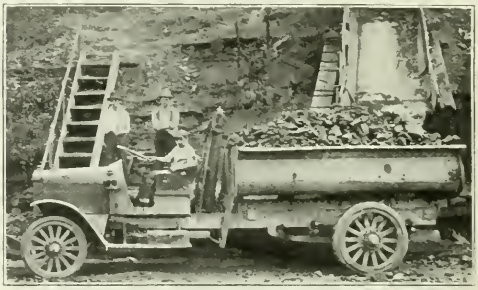
POWER WINCH ON DUPLEX TRUCK HOISTS 60-FT. SMOKE STACK.

from the transmission by a worm and worm wheel. An exclusive feature is the fact that the winch is located under the driver's seat and uses none of the space back of the seat. It has been thoroughly tested by Duplex engineers and is declared to be satisfactory in every way.

The accompanying view shows a Duplex power windlass hoisting a 60-ft. section of a smoke stack at the Duplex factory in Lansing. The section is 40 ins. in diameter and weighs 5 tons. It was easily lifted into place by the winch, the hoisting operation requiring but a few minutes.

3½-Ton Truck Replaces Seven Teams and Seven Men

A 3½-ton Acme motor truck operated by the Glass Run Coal Company of Pittsburgh, Pa., replaced seven teams and seven men in hauling coal. The roads traversed were in fair condition. The length of haul was two miles. The number of trips made per day with the truck was 14 and with team 3. Work continued with the truck from 7 a. m. to 4 p. m. The truck driver was paid $3.60 per day. The truck carried 4½



ACME 3½-TON TRUCK THAT REPLACED SEVEN TEAMS.

tons per load—a full ton above the rated capacity. There were no truck repairs necessary. The cost of gasoline was $2.16 per day; oil, 17½ cts.; grease, 5 cts.; miscellaneous expense, 1 ct.; total cost per day, $5.99½. The total mileage was 60 per day. To travel the same 60 miles per day with the same total load by team, 7 teamsters were required at $3 each and seven teams of horses, hauling 3 tons at a load. The best day's performance with the truck was the hauling of 85 tons of coal, making 19 trips for a total mileage of 80.

The Highly Developed Motor Truck Trailer

The modern motor truck trailer is fitted with solid rubber tires and the axles revolve on steel roller bearings. These trailers are "engineered" and built just like motor trucks. They are built to carry capacity loads with a 50 per cent overload allowance. Trailers are here to stay because they increase carrying capacity and reduce hauling costs. Their operating expense is negligible. The high grade motor truck has great reserve power, seldom called into action unless trailers are employed.

A 1-ton truck can pull two or even three tons on a trailer. If the trailer can be attached to the truck frame by a fifth wheel connection making what is practically a six-wheel truck, the load handled can be as great as three tons, easily. Seventy per cent of the burden is borne by the semi-trailer, 30 per cent is handled by the truck.

Semi-trailers are made, ordinarily, in 1½, 3 and 5-ton guaranteed capacities. They are furnished with standard stake bodies or bodies may be ordered to suit the special hauling requirements. This type of hauling unit is especially adapted for building supply dealers, lumber dealers, coal men, pit and quarry operators, telephone companies, manufacturers, general contractors, and road builders.

Pole trailers with extension reach and swivel bolsters which will handle long pole or pipe lengths as long as 100 ft. are used in the timber, by telephone companies, by public service organizations and the oil fields. Small two-wheel trailers, attached to any small truck or pleasure car, are used by those who can use a hauling unit of capacity not greater than 1,500 lbs.

The demand for properly built trailers is especially strong where long hauls are necessary. If the Semi-Trailer is properly "engineered," it should be built to run just as fast as the truck can pull it. It should be attacked by a connection that will nullify the bumps and jars received on bad roads and absorb the shocks of sudden starting and stopping. On long hauls a high-speed trailer is especially profitable because one trip it handles a capacity load that otherwise could not be taken care of less than three.

There is a strong demand for Semi-Trailers among city operators where the hauls are short because the use of trailers enables the owners to keep their trucks moving. The trailer should be the loading platform—the truck, the power unit. One operator in a middle western city operates three Semi-Trailers and one Tractor-Truck. At one end of the haul is the railroad—at the other end the lumber yard. While the semi-trailer and tractor do the work of three 1-ton trucks, being unloaded in the yard while the third is being hauled by the truck. The truck is always in motion. On each trip the semi-trailer and tractor do the work of three 1-ton trucks.

Some New Machinery for Road Builders

Now that labor is scarce, contractors are paying more attention than heretofore to machinery which will reduce the size of the gangs needed for road building. It is found that while some kinds of machinery may somewhat increase the cost of performing certain kinds of work, as compared with the cost where hand labor is used exclusively, it is to the contractor's advantage to pay this slight additional cost in order to be certain that the work will progress rapidly and be completed on time. What the contractor is interested in is the net profit on the whole contract, rather than the lowest possible price on some item of the work. If mechanical equipment will also be more economical than day labor on such an item, so much the better.

A form of grading machine is being used in an Illinois county which is typical of the labor-saving improvements recently made. It is a heavy blade grader, which digs the surface of a road and sweeps the material to one side. There is a limit, however, to the material which can be dug up by the blade of such a grader. Consequently in grading old roads which are so consolidated that the crust is very hard, it has been customary to loosen this crust in advance of the grading. The new machine makes this preliminary work unnecessary, for in front of the blades it has a head carrying five heavy teeth on the lower side. These teeth are forced into the road and tear up a strip 40 in. wide. By loosening a strip of this width the blade of the grader is able to loosen and move to one side a considerably wider section of the old roadway. This machine is hauled by a traction engine and can cut down a hard roadway for a depth of 4 in., if necessary, every time it passes over the road. In this particular case it is cutting down the road from 6 to 15 in., leaving it in good condition for a concrete pavement.

Another type of grading machine is being used on a Chicago boulevard. It has an endless belt of steel links, which carry strong buckets about 5 ft. wide, arranged like the buckets on trench digging machines. This machine crawls along just as the tanks of the British army move, and the buckets, as they are slowly moved by the endless chains, scrape off the surface of the earth and carry this material to a hopper on the top of the machine, from which it is delivered through a chute into wagons moving along beside the excavator until they are filled. Both these machines are new, and the interest shown in them is proof of the importance with which labor-saving equipment is now regarded by experienced road contractors.

Advance Information on Big Jobs

Road Building in Michigan During 1917 and Proposed Work for 1918

By Leroy C. Smith, Deputy State Highway Commissioner. Lansing, Mich.

The war situation has had its effect upon road building projects during the past year to considerable extent. All townships and counties which were dependent upon foreign shipments of road-building material were compelled to cut down their proposed work considerably on account of the lack of railroad equipment for hauling gravel and stone.

Loss of Stone Boat Hurts

Western Michigan was particularly handicapped this year because of the loss of a large stone boat on Lake Michigan, which, during previous years, had been bringing stone in from Wisconsin for road building along the West Michigan Pike and branch highways. It was almost impossible for this boat to be replaced, all shipyards being tied up with government work. Many gravel and stone companies resorted to the use of box cars for shipping their material all during the fall of 1917, and on November 1 the Government put into effect an order known as Priority Order No. 2, which removed all open top cars, such as gondolas, from any service for hauling road material. This came at a time when contractors were trying to complete their jobs and when the county and township officials were arranging to stock the necessary material to maintain their old roads.

Much Important Work Done

Notwithstanding this handicap, many important links in the highway system of the state have been closed in during the past year. Genesee County has been rebuilding of concrete and bituminous concrete the road from Saginaw to Detroit across that county and an extension of this road is contemplated this year across Oakland County. When this work is completed a through road will be provided from Saginaw to Detroit. This is especially important since overland "driveways" have been practiced by automobile companies to make deliveries of cars and trucks.

Three Military Roads

The State has been taking active interest in road building during the past year, having in hand three roads of military importance; one at Mt. Clemens, leading to the Selfridge Aviation Field; one at Camp Custer and a detour between Detroit and Monroe on the Toledo road. These projects are all completed and open to traffic, except the Toledo road, upon which work is now being rushed and probably will be completed within a week or two. The latter road is a very important connection between Detroit and east, over which automobiles and trucks will be delivered to the seaboard, thus relieving the already congested railroads.

Good Work Despite Delays

Notwithstanding the delays and handicap, much progress has been made in road work during the past year, and it is safe to say that at least as many miles of road were completed and opened to traffic during 1917 as during 1916. However, there has been no increase in mileage completed.

$4,000,000 Available for 1918

During 1918 there will be available over $4,000,000 for road improvement in the various counties of the state. Coupled with this will be a state reward and auto tax fund, amounting to nearly $2,000,000 and a federal aid fund amounting to approximately $500,000. Many important links in the trunk line highway system of the state will be filled in, providing cars are available for shipping road building material. If railroad equipment can not be assigned to highway work this year, it will, of course, limit expenditures and make it necessary to resort to auto truck and the building of roads where local material is available.

1,000 Miles of Road Contemplated

Approximately 1,000 miles of road are contemplated this year by the State and counties. This is not an exceptionally large mileage, in fact a slight decrease over some years in the past; but the work is of a higher quality. In many cases pavements are planned and most of the work will be along lines of through roads connecting up the larger cities of the State.

Important County Work

Berrien county has available about $125,000 in direct county road tax, which will be expended upon about 15 miles of important road.

Calhoun county has $300,000 worth of county bonds available which will be expended upon 40 miles of road, in addition to $70,000 county road tax, which will be expended upon 50 miles of important road.

Genesee county has nearly $300,000 available for road work this year, which will be expended upon 40 miles of road, connecting up and resurfacing a number of miles of old state rewarded gravel road which have become inadequate.

Kalamazoo county has $130,000 available for road work; Muskegon county has $80,000 available for road improvement, and Oakland county has nearly $300,000 to be expended upon roads.

Twelve Federal Aid Projects

Construction work will start next year on twelve Federal Aid Projects, the cost of which is divided between the Federal Government, the State and the county or township through which the roads pass. These projects are outlined with a view of filling in gaps of the trunk line system of the state, upon which it is hard to secure local funds to make the necessary improvements.

On the West Michigan Pike two projects are contemplated across Allegan county and one connecting Van Buren and Berrien counties. Another project on the West Michigan Pike is to be considered between Muskegon and Shelby.

On the Mackinaw Trail three Federal Aid Projects will be built this year, one connecting up the road across Osceola county, between Big Rapids and Cadillac. Another important project is south of Grand Rapids in St. Joseph county.

On the Detroit-Chicago Highway several Federal Aid Projects are being surveyed, two in Washtenaw county between Ypsilanti and Ann Arbor and between Ypsilanti and the Wayne county line. Another project east of Kalamazoo for six miles leading towards Battle Creek and Camp Custer.

Work will be started this year on 50 miles of road between Marquette and Houghton in the upper peninsula. This road, built with the assistance of the Federal Government, will connect the iron and copper industries of the upper peninsula, which heretofore have never been connected by an important highway.

On the Wolverine Pavedway between Grand Haven, Grand Rapids and Detroit, a number of Federal Aid Projects will be built. Important among these is a gap of eight miles in Livingston county, near Howell. In addition to this, Ottawa county proposes extending their concrete pavement in the direction of Grand Rapids.

Preparing for Motor Truck Freight Haulage

In all the work contemplated during 1917 especial attention is being given to trunk line roads. It is more important now than ever that main cities of the state be connected with good roads so that trucks can be operated to take care of short-haul freight. It is improbable if the war situation will be much improved until after the war. Eastern cities are making provisions for caring for this increased traffic, and it is only a matter of time until Michigan will have to meet it.

Highway Construction in Wisconsin in 1918

M. W. Torkelson, Assistant Engineer, Wisconsin Highway Commission, writes as follows of the construction program of his department for the year 1918:

It is impossible to give this statement in any great detail. We have under consideration Federal aid work in 57 of our 71 counties, the estimated aggregate cost of which will be approximately $2,000,000. We have in addition state aid work projected in every county, the estimated aggregate of this amounting to approximately $2,500,000. In addition we have a maintenance program projected which it is expected will involve an expenditure of approximately $875,000.

As regards construction, we have adopted a middle of the road policy; that is, we expect to do such work as can reasonably be done and to leave such work as is extremely difficult of execution and such work as cannot be done except at unwarranted costs for future years. Certain trunk highway improvements we consider of sufficient importance to justify prices which ordinarily would be considered extravagant, and we expect to use our best efforts to see that these are carried out. But roads that are of minor or purely local importance can, we believe, well wait until times of less stress. The maintenance program will be our first care and we expect to devote every effort to make this a complete success, even though the construction program should thereby be reduced to a minimum. We realize that a large percentage of our highways will for many years to come continue to be unsurfaced; that travel over these roads for probably 150 days of the year is reasonably possible even under present conditions.

We believe that systematic maintenance and care will decrease the number of days when these roads are impassable to a very marked extent, and it is our belief that the benefit that will result at the present time from systematic maintenance of these roads will be much greater than that which will result from the construction of much shorter pieces of high type pavements.

This statement is, of course, general, and there will naturally be exceptions.

Proposed 1918 Road Work in Alabama

By J. B. Converse, Assistant State Highway Engineer of Alabama, Montgomery, Ala.

Road work in Alabama was curtailed to some extent during the latter part of 1917 due to war conditions and Government Priority Order No. 2. However, this has not made the State Highway Department take a pessimistic view for the year ahead. The department has believed that it would only be a question of a very short time before the importance of maintaining and building through routes to relieve the railroads of short hauls would assert itself. This has already been demonstrated by the movement of trucks from inland cities to ports of embarkation via the highways. Today in Alabama the Government is advertising for bids for an auto

truck service from Montgomery to Birmingham, a distance of approximately 105 miles; from Montgomery to Columbus, Ga., 80 miles; and from Montgomery to Andalusia, Ala., 90 miles. With facts like these before us, it is reasonable to believe that the Government, as operator of the railroads, will soon release cars for the shipment of road building material for trunk lines.

Due to the splendid distribution of road building material throughout the state, only about 25 per cent of the counties are affected by the car shortage. However, the cost and uncertainty of labor has become a serious problem for all.

The principal labor supply for roadwork in the South is the negro and the great demand for labor in the building of the many cantonments has doubled and trebled his wages with the following result: On Saturday night the average negro laborer finds himself with much more money than he needs to settle his indebtedness, and such being the case he proceeds to do the customary thing with them under such a condition—he stops work until his funds are exhausted. This state of affairs has caused the road contractor to protect himself by bidding so high that in many cases the prices are prohibitive and for a few months last fall it seemed as though 1918 work in Alabama would be confined to counties that were equipped to do the work themselves. However, the bulk of cantonment building is over now and there is hope that labor conditions will return to normal even if at a somewhat higher level.

There will be available for road work in 1918 the regular state aid and county supplement fund amounting to approximately $375,000. The Federal aid available, including past appropriations and the appropriation for the Government's fiscal year 1919, available July 1, 1918, will be $624,899.17. A like amount from the state and counties will make $1,249,798.34. Most of the state aid and county supplement fund will be probably used in supplementing Federal aid funds; however, it may be expected that $100,000 will be used distinct and separate from the Government work. The grand total of all is $1,349,798.14.

Surveys and plans have been made for 25 approved projects, comprising 171 miles of road. Contracts have been signed or work started with county forces on ten of these projects, consisting of 83 miles. It is contemplated that all of this work will be completed in 1918, and in addition thereto work will probably start on 25 other projects. These improvements are confined entirely to state trunk roads connecting main centers of population. At this date the department has contracts held up for 36 miles of the 1918 roadwork because of war conditions.

Much Construction on Lincoln Highway Contemplated in Ohio

As a result of the request of Governor Cox that every effort be put forth in each county for the improvement of the Lincoln Highway, announcement is made by Wyandotte county of an appropriation of $60,000 for such construction. Samuel J. Black, Wyandotte county counsel of the Lincoln Highway Association, states that $30,000 of this sum will come from the state through the State Highway Department and the remaining $30,000 will be provided by the county.

The funds thus made available will take care of the permanent improvement of all of that section of the Lincoln Highway between Upper Sandusky and Nevada, and will allow for considerable construction work to the west of Upper Sandusky as well.

Great constructional activity will be marked all along the route of the Lincoln Highway in Ohio in 1918. In addition to the work in Wyandotte county, permanent improvement will be undertaken in Columbianna, Stark, Crawford, Hardin, Allen, Richland, Ashland and Van Wert and Wayne counties. With such remarkable headway established it is easy to foresee the complete, permanent improvement of the Lincoln Highway across the state in 1920.

South Dakota Road Building Program for 1918

By Frank S. Peck, Highway Engineer, Pierre, S. Dak.

While the Highway Commission of South Dakota is new, having been born about August 1, 1917, South Dakota counties have long been building expensive highways under the direction of competent engineers. Lawrence county, in particular, has been in the road-building game for seven or eight years, and has expended $500,000 on her mountain roads, which are praised as up-to-date highways.

As to the road-building program for 1918, I will give a summary of the projects upon which federal, state and county aid funds have been pledged, and in all probability will be built in 1918.

Minnehaha county	$ 39,400.00
Codington county	38,832.00
Deuel county	28,943.20
Grant county	34,130.72
Moody county	30,200.00
Brookings county	20,000.00
Lincoln county	41,728.94
Total	$235,234.86

These projects are all subject to the approval of the Federal Government. All of the projects call for hard surfacing with local gravel, except Minnehaha county, which will be an asphalt-macadam proposition. We expect and have hopes of getting these projects in shape to begin advertising in early spring and start construction work as soon as weather conditions will admit.

The personnel of the South Dakota Highway Commission consists of Governor Peter Norbeck, chairman; Homer M. Derr, State Engineer, secretary; Frank S. Peck, Highway Engineer, and Fred W. Schreiber, Assistant Highway Engineer, in charge of field parties.

Need of More Intensive Maintenance and Greater Use of Machinery on Construction Indicated in Minnesota

By John H. Mullen, Deputy Commissioner of Highways, State Highway Department, St. Paul, Minn.

Preliminary reports of accomplishment on State Aid road work in Minnesota during the year 1917 indicate that approximately three-fourths of the work contemplated last spring will have been completed during the year. In round numbers this will mean approximately 1,500 miles of grading, 500 miles of surfacing and 200 bridges. The cost reports submitted to date, show expenditures for construction amounting to about $3,000,000 and maintenance $500,000, not including the work done in the three larger counties, Ramsey, Hennepin and St. Louis, which are not subject to requirements of the State Highway Department, and in which the expenditures for road construction and maintenance amounted to about $1,200,000 for 1917.

1917 a Difficult Year

It was a rather difficult problem to carry on road improvements during 1917, for the labor situation in this part of the country was very uncertain and not only was the cost of materials both high, but the materials were difficult to obtain. The net result of the year's experience from an administration standpoint, is the showing of necessity for more intensive maintenance and for the use of machinery on a greater scale in construction work. This necessitates a slightly different layout of construction plans and in the end will result in lower cost of work. Therefore, it might be said that the present condition of affairs is a very good thing for the advance-

ment of road building in that it has demanded more efficient and economical methods in handling the work.

Maintenance the Big Thing

The maintenance however, is the big thing, and even though the road building business were paralyzed an intensive system of maintenance will result in good road conditions throughout the country. For this reason the Highway Department will devote particular attention to that branch of the work during 1918 and will endeavor to maintain in as good condition as possible all of the main lines of travel. On both construction and maintenance, 1917 was marked by the much greater use of tractors and other motive power which released teams and men for agricultural work. Up to just recently, the grading and some of the construction work was considered a source of income for the farmers, and the introduction of outside machinery and equipment was somewhat resented, but a rapid transition has taken place, and now as a general thing, it is only as a contribution to the good roads cause that farmers will use their equipment on road work. The prospects for 1918 work are very good so far as available funds are concerned. As compared with the total of $4,700,000 available for 1917 there will be a total of $7,500,000 available for 1918. The increase is occasioned by a raise in the county road and bridge levies of approximately $1,000,000; increased State Aid for 1918 amounting to $500,000; the total apportionments of Federal Aid for the first three fiscal years which will be expended in 1918, amounting to $853,047; with special county levies to meet Federal Aid in amount of approximately $500,000.

Federal Aid Work

The Federal Aid work, which it was expected would be started during 1917, did not open up, excepting on the portion of the Twin Cities-Duluth highway through Chicago County. With the available funds for 1918, it is expected that most of the main lines of travel will be connected up with surfaced roads. This includes the completion of the Twin Cities-Duluth highway; the extension of the Jefferson highway to the Iowa State line; the construction of the Scenic highway through from the Twin Cities to the Cass Lake and Leech region; the National Parks highway connection to Winona and from St. Cloud to Fergus Falls; the Glacier Park highway as far west as Willmar; the Yellowstone Trail to Granite Falls; and the Chicago, Black Hills and Yellowstone Park trail from Winona to the Dakota line, which will probably be the first complete surfaced road across the State of Minnesota. This road passes through Rochester, Owatonna, Mankato and Tracy. With a small amount of work in Cook County this year, there will be first class road from the Twin Cities to Port Arthur, Ont. It was only in 1917 that the connection was made between the Ontario and the Minnesota road so that traffic was able to get through. This road has opened up a wonderful recreation district and it passes through a section of the State with which but very few of our citizens are familiar. This district is cut up by mountain ranges, beautiful streams and lakes and abounds with game and fish. The completion of the Scenic Highway, will open up another district slightly different but fully as desirable from a recreation standpoint. This is the territory through the Millelacs, Leech and Cass Lake country and includes the greater portion of the pine timber lake region. Driving through this region one is hardly out of sight of a sand beech lake at any time. The National Parks Highway will make more accessible the great chain of lakes lying in the vicinity of Osakis, Alexandria, Fergus Falls and Detroit. This territory is of a different nature than the other recreation districts as it is situated in the hard wood timber belt. This region affords probably the best bass fishing in the country and has very good facilities for tourists.

Tourist Traffic

It is expected that a great deal of tourist traffic will have to be taken care of this year, in fact last year saw a great increase in the volume of motor traffic in Minnesota. For instance, a week's traffic census on State Road No. 1, Dakota County, which is the main road leading in from Iowa to the Twin Cities, showed an average of 1,129 automobiles per day, the National Parks highway in Sherburne County carried an average of 433 automobiles per day, while other main roads leading to recreation districts, carried an average of from 250 to 600 automobiles per day. With the improvement of the main lines which is contemplated it is reasonable to assume that the main arterial highways from the south will carry on an average of 1,000 machines per day, while the main lines to the recreation districts will have as a general average about 600 machines per day. A careful count of automobile traffic has shown an average of 3½ passengers per automobile. From this basis deductions can be drawn as to volume of traffic and probably expenditures by tourists.

Interurban Buss Service

An interesting feature of road development in Minnesota, is the increase in interurban buss service, particularly in the northern part of the state, where it was not expected that such service would be patronized to any great extent. There are a great many of such lines, but one buss line in particular, 160 miles long, runs on a time schedule similar to the railroad train service, and is able to maintain this schedule with running time of over 20 miles per hour.

Freight Haulage on Highways

The freight haulage by highways has not developed to any great extent in this State as yet, but this is due partly to the fact that main lines of travel have not been connected up. The road authorities are expecting that this traffic will come in great volume in 1918 on account of car shortage and insufficient railroad equipment, which will porbably result in the necessity for more durable types of roadway than are in use at the present time.

Minnesota has adopted the policy of building gravel surfaced roads and intends to carry this work forward this year but with the full realization of the fact that it is only a short time until our main lines of highways must be surfaced with a more durable pavement to withstand the heavy motor truck and rapid passenger vehicle traffic to which these roads will be subjected.

Features of Good Road Work in New Mexico

By James A. French, State Highway Engineer, Santa Fe, N. M.

The road building season in New Mexico covers the time from January 1 to December 31. Some few exceptions may be made to the above statement, and I herewith note them: In the high mountain ranges, where the rainfall (including snowfall) exceeds 20 in. annually, it is not advisable to attempt road construction during the months of December, January, February and March, but this area is so small in comparison with the area of the state as a whole that it should not be considered in the statement above. Another setback to extensive road construction may come during the period of an extended drouth, these drouths lasting from six to ten months and occurring at intervals of ten years or longer, hence they cannot be considered as changing the above statement. When the question is asked, then, "What is the road-building season?" or "When does it begin or end?" it may be truthfully said that the road-building season is continuous throughout the year. Frequently I have known construction camps that have worked their 313 working days in a year without the loss of a single day from inclement weather conditions.

Recent Road Expenditures

During the fiscal year, November 30, 1916, to November 30, 1917, the state expended $262,000 in roads and highway bridges. During the same period the counties expended $361,000, or a combined total of $632,000 by state and counties.

During the fiscal year, November 30, 1915, to November 30, 1916, the state expended $462,000 and the counties expended approximately $400,000, or a combined total of $862,000. The combined expenditures of 1916 exceeded the 1917 expenditures owing to the fact that the State Road bonds were available during 1916.

Money Available for 1918

During the fiscal year 1918 the state will have available $376,900 and the counties $614,900, or a combined total of $991,800.

The Forest Service has distributed to the counties having forest reserves within their boundaries $29,200. There is available and to be expended by the Forest Service under its direction $110,000 for the year 1918. Two counties have bond issues amounting to $125,000, available during 1918. Under the Federal Aid act there is available for 1918 the sum of $236,000.

The above figures indicate that there has been no lessening in the sentiment for highway construction throughout the state. The indications are that the sentiment is overwhelmingly in favor of a continued and extensive program of road building. The total sum outlined above, viz., $1,492,000, for highways during 1918 is indicative of the wishes of the taxpayers throughout the state.

The war has had some effect in our state upon certain classes of labor, more particularly the semi-skilled labor, but, generally speaking, there has not been much change, except that the prices of labor have increased.

Use of Convict Labor

Convicts are used and there have been at times from one to three camps at work during the past year, all under the honor system. Recently, under a new arrangement with the penitentiary authorities, I have made a contract with the superintendent of the penitentiary to furnish me convicts on the road grade at $1 per day of eight hours. The penitentiary furnishes all cost of the convicts, our foreman hiring the men as any day laborer would be hired. In addition, the penitentiary pays each convict 15 cents per day. After two months' work under this arrangement I am satisfied with its efficiency.

Post Roads Unimportant in Sparsely Settled States

To date eleven Federal Aid projects have been submitted to the Department of Agriculture, but so far the result has not been learned. I am of the opinion that some amendment should be made to the Federal act to give more authority to the Secretary of Agriculture to build the main highways, regardless of the post-road phase, which in this state starts roads anywhere and ends them nowhere. I believe this feeling is shared by the neighboring states, as our conditions are similar and differ from the conditions in the thickly settled states.

U. S. Intercity Parcel Post Motor Truck Routes

At the present time (February 1) the United States government either has in actual operation or has authorized seven routes for highway express and freight trains. In addition, the Postoffice Department has under advisement the establishment of 41 other main routes and 10 feeder routes to traverse various sections of the country.

The proposition laid out by the government contemplates main truck lines that will cross the country from east to west and from north to south, with numerous feeder routes. The plans of the Postoffice Department in this connection were explained in Chicago recently by James I. Blakeslee, Fourth Assistant Postmaster General, in charge of the rural free delivery branch of the postal service, in addressing the newly organized Highway Industries Association.

"The Postoffice Department is deeply interested in the progress of road work," Mr. Blakeslee said. "In every producing section of the country today there is bound to be a reduction in production, a condition brought about by the fact that so many men have been called into war service.

"It is vitally essential that there should be an increase in production and one of the best ways to bring this about is to give the producer the best possible means of transportation. To this end we would inaugurate a vast system of motor truck lines, over which manufactured articles as well as farm products might be transported cheaply and quickly from the producer to the consumer.

"Along one line of motor truck transportation now in service we investigated and discovered that under the ordinary system it was necessary to handle a case of eggs 14 times between the producer and the consumer. Our truck line delivers a case of eggs with only two or three handlings at the most.

"On a two weeks' test between Philadelphia and Oxford, Pa., a distance of 120 miles, our truck surmounted all difficulties, including snow and ice, and was not more than 20 minutes behind schedule at any time.

"The government motor truck service as laid out would consist of trunk lines or through connection routes and feeder or short-line routes. The trunk lines naturally would be located between large cities in order that a good market would be available at both ends of the route. In this way the trucks would be loaded going both ways.

"Feeder routes could be located so as to provide for quick transportation from the main lines to the various markets provided, thereby bringing the producers in the great garden truck territories into direct daily communication with the consumers. The plans call for about 125 trucks to start."

The government lines now in operation and authorized include the operation of trucks between Philadelphia and Baltimore, Baltimore and Washington, Columbus and Zanesville, Philadelphia and Atlantic City, Washington and Leonardtown, Baltimore and Solomon Island, and Baltimore and Lancaster. The other fifty main and feeder lines will cover various routes through the east, central west and the south.

Lines between Chicago and Springfield, O., and between Chicago and Indianapolis are expected to be in operation within the next sixty days.

According to Mr. Blakeslee, the object is to enlarge the delivery zone of every city through which the lines will pass. This should have a tendency not only to prevent prices of produce from going higher, but should reduce them.

On the motor truck mail route between Washington and Baltimore trucks leave each city daily at 6 a. m. The truck trains meet midway between the two cities, exchange loads, and return to their starting points.

Coming Conventions

UNITED STATES GOOD ROADS MACHINERY EXHIBIT—Exhibit at Little Rock, Ark., April 15-19. Sec'y., J. A. Rountree, 1021 Brown-Marx Bldg., Birmingham, Ala.

UNITED STATES GOOD ROADS ASSOCIATION—Will convene in Little Rock, Ark., April 15-17. U. S. Senator J. H. Bankhead, Pres. Sec'y., J. A. Rountree, 1021 Brown-Marx Bldg., Birmingham, Ala.

BANKHEAD NATIONAL HIGHWAY ASSOCIATION—Will convene in Little Rock, Ark., April 18-19. T. S. Plowman, Pres. Sec'y., J. A. Rountree, 1021 Brown-Marx Bldg., Birmingham, Ala.

How the Contractors are Bidding

Bidding Prices on Enlargment of Rapid Sand Water Filters at Fort Worth, Texas

Table 1 herewith gives in parallel columns the engineer's estimate of cost and the bids submitted on the enlargement of the water filtration plant at Fort Worth, Texas, by the construction of additional filters. The bids were received January 30, 1918. J. VanZuben is city engineer and John H. Gregory, 170 Broadway, New York, is consulting and designing engineer on the work. The contract was awarded to the Pittsburgh Filter Manufacturing Company, Pittsburgh, Pa.

Some Unit Bids Submitted on Okmulgee, Okla., County Roads

Herewith are given some of the unit prices bid by various contractors on the Okmulgee County, Oklahoma, Roads on December 11, 1917, as furnished this journal by Harrington, Howard & Ash, Consulting Engineers, Kansas City, Mo.

Park-Moran Company

The Park-Moran Company, bidding on nine sections, bid from $2.18 to $2.40 per square yard for monolithic brick complete.

Hanlon & Okes

Hanlon & Okes, bidding on ten sections, bid $1.85 per square yard on bituminous macadam complete, and $2.35 on asphaltic concrete complete. Their bid on five sections was $1.96 for concrete complete.

J. K. Shinn

J. K. Shinn bid $2.30 per square yard on concrete pavement complete on four sections and $2.34 on two sections.

James Stanton

James Stanton bid $2.24 on concrete pavement complete on three sections and $2.22 on three other sections.

W. A. Swatek & Co.

W. A. Swatek & Co., bidding on three sections, bid $2.05 per square yard on bituminous macadam complete, $2.15 on concrete complete and $2.41 on monolithic brick complete.

Warren Bros. Company

Warren Brothers Company, bidding on 13 sections, bid from $1.33 to $1.39 on asphaltic concrete No. 1, except base, and from $1.28 to $1.34 on asphaltic concrete No. 2, except base. They also bid from 88 cts. to 94 cts. on labor on wearing course of asphaltic concrete No. 1 and No. 2.

J. J. Harrison Construction Company

The J. J. Harrison Construction Company, bidding on 19 sections, bid $1.40 ($1.50) per cu. yd. on solid rock excavation, 70 (80) cts. on intermediate excavation and 40 (40) cts. on common excavation; $30 ($25) per 1,000 ft. on machine grading; 20 (40) cts. per lin. ft. on rock subdrains; from 85 cts. to $1.50 ($1.25) for placing 12 to 18-in. culverts per lin. ft., $1.72 to $3.20 ($1.75) on 24-30-in. culverts and $2.21 to $4.95 ($2.25) on 36-42-in. culverts; $9 ($9) per cu. yd. on rubble stone headwalls for drains; from $6.40 to $14 per cu. yd. for hauling and placing slabs in culverts ($8.25); 65 cts. ($1.25) for paving waterways slab culverts, and $9 ($10) per cu. yd. for rubble stone masonry in culverts.

S. P. Romans

The bids of S. P. Romans covered the same items as those of the J. J. Harrison Company and are given in parenthesis in each case after the Harrison bid.

F. P. McCormick

The bids of F. P. McCormick covered the same items, in general, as those of the Western Paving Company, and are given in parenthesis in each case after the Western bid. The Western Paving Company bid $1.68 ($1.80) on solid rock, 84 (90) cts. on intermediate, and 48 (40) cts. on common excavation, respectively; $36 ($40) on machine grading per 1,000 ft; 24 (25) cts. on rock subdrains per lin. ft.; from $1.02 to $1.80 ($1.85) for placing 12-18-in. culverts per foot; $2.06 to $3.84 ($3.85) for placing 24-30-in. culverts per ft.; $2.65 to

TABLE I—ENGINEER'S ESTIMATE OF COST AND CONTRACTORS' BIDS FOR ENLARGING MECHANICAL FILTER PLANT AT FORT WORTH, TEXAS.

	Item	Quantity	Engineer's Estimate Price	Engineer's Estimate Amount	Pittsburgh Filter Mfg. Co. Pittsburgh, Pa. Price	Pittsburgh Filter Mfg. Co. Pittsburgh, Pa. Amount	N. Y. Continental Jewel Filtration Co., New York, N. Y. Price	N. Y. Continental Jewel Filtration Co., New York, N. Y. Amount
1.	Excavation	1,800 cu. yds.	$ 0.50	$ 900.00	$ 1.05	$ 1,890.00	$ 1.25	$ 2,250.00
2.	Removing vault and appurtenant work	lump sum	.....	500.00	.....	200.00	.....	1,200.00
3.	18-inch sewer	lump sum	.....	400.00	.....	600.00	.....	425.00
4.	Steam supply main	lump sum	.....	580.00	.....	950.00	.....	1,200.00
5.	Cast iron pipe	16 tons	80.00	1,280.00	138.00	2,208.00	152.00	2,432.00
6.	Bell and spigot special castings	3 tons	100.00	300.00	200.00	600.00	240.00	720.00
7.	Concrete in substructure and superstructure	lump sum	.....	6,540.00	.....	8,000.00	.....	13,000.00
8.	Miscellaneous steel and cast iron fittings	lump sum	.....	300.00	.....	450.00	.....	1,300.00
9.	Filter tanks	4	2,600.00	10,400.00	1,600.00	6,400.00	2,500.00	10,000.00
10.	Strainer systems	4	1,575.00	6,300.00	1,500.00	6,000.00	3,157.00	12,628.00
11.	Filter gravel	lump sum	.....	1,100.00	.....	1,000.00	.....	2,347.00
12.	Filter sand	lump sum	.....	1,800.00	.....	2,800.00	.....	4,800.00
13.	Rate controllers and loss of head gages	4	1,200.00	4,800.00	.....	.....	.....	.....
	A—Builders Iron Foundry make	4	.....	.....	1,200.00	4,800.00	1,725.00	6,900.00
	B—Pittsburgh make: Venturi type	4	.....	.....	900.00	3,600.00	.....	.....
	C—Pittsburgh make: Self-contained type	4	.....	.....	700.00	2,800.00	.....	.....
14.	Operating tables	4	700.00	2,800.00	.....	.....	.....	.....
	A—Pittsburgh make	4	.....	.....	490.00	1,960.00	.....	.....
	B—New York make	1	.....	.....	.....	.....	480.00	1,920.00
15.	Filter gallery piping	lump sum	.....	13,000.00	.....	.....	.....	.....
	A—With Ludlow valves	lump sum	.....	.....	.....	19,000.00	.....	22,200.00
	B—With Renselaer valves	lump sum	.....	.....	.....	18,000.00	.....	.....
16.	24-inch wash water meter	lump sum	.....	2,350.00	.....	.....	.....	.....
	A—Builders Iron Foundry make	lump sum	.....	.....	.....	2,500.00	.....	2,700.00
	B—Pittsburgh make	lump sum	.....	.....	.....	1,300.00	.....	.....
17.	Wash water tank control	lump sum	.....	800.00	.....	500.00	.....	800.00
18.	Moving wash water pump	lump sum	.....	250.00	.....	300.00	.....	375.00
19.	Chlorine control apparatus—stationary type	lump sum	.....	950.00	.....	800.00	.....	1,050.00
20.	Chlorine control apparatus—portable type	lump sum	.....	450.00	.....	550.00	.....	625.00
21.	Building construction	lump sum	.....	7,500.00	.....	7,000.00	.....	9,100.00
	Total—Maximum			$63,300.00		$68,508.00		$97,972.00
	Total—Minimum			63,300.00		64,308.00		97,972.00

$5.95 ($5.85) for placing 36-42-in. culverts per foot; $10.80 ($10.90) for rubble stone headwalls for drains, per cu. yd.; $7.68 to $16.80 ($10.10) for hauling and placing slabs on culvert, per cu. yd.; 80 ($1.00) cts. per sq. yd. for paving waterways slab culverts; $1.73 to $1.93 ($1.85) per sq. yd. for bituminous macadam; $1.00 ($1.08) per sq. yd. for broken stone paving base in place; $1.28 (—) for asphalt concrete paving No. 1 except base; $2.28 to $2.34 (—) for asphalt concrete pavement No. 1 complete; $1.23 ($1.32) for asphalt concrete pavement No. 2 except base, and $2.23 ($2.35) for asphalt concrete pavement No. 2 complete.

Bids on Pipe Drainage System at Garden Prairie, Ill.

On November 15, 1917, bids were asked by the commissioners of Coon Creek drainage district, at Garden Prairie, Ill. Bids were asked for the furnishing and laying of 4,222 ft. of 27-in. tile; 3,200 ft. of 26-in.; 3,100 ft. of 24-in.; 700 ft. of 22-in.; 2,600 ft. of 14-in.; 600 ft. of 12-in.; 7,175 ft. of 10-in.; 4,965 ft. of 8-in.; 3,070 ft. of 6-in.; also 1 intake for 22-in. tile and 6 cement bulkheads.

Bids were accepted separately for material and for all labor, including hauling, etc.; also for the complete job.

The following are the total quantities required of each sized tile: 3,070 ft. 6-in.; 4,965 ft. 8-in.; 7,175 ft. 10-in.; 600 ft. 12 in.; 2,600 ft. 14-in.; 700 ft. 22-in.; 3,100 ft. 24-in.; 3,200 ft. 26-in. and 4,222 ft. 27-in.

On the tile the 22 to 27-in. trench was from 4½ to 6 ft. deep. Balance of the work ranged from 3 ft. deep to 6 ft. The work of hauling the tile an average of 4 to 5 miles was let at $30 per carload, each carload making about 10 wagon loads. No bids were received for laying 22, 24 and 26-in. tile. This work and 10 miles additional will be let some time this winter, reports Arthur L. Webster, municipal and drainage engineer and county surveyor, Wheaton, Ill., engineer on this work.

The following bids were received:

Millard Carr, DeKalb, Ill.—

2,175 ft. 10-in. at 16 cts.; 600 ft. 12-in. at 20 cts.; 2,600 ft. 14-in. at 29 cts.; 4,222 ft. 27-in. at 61 cts.

Frank Greene, Garden Prairie, Ill.—

—McCue Connection—

425 ft. 6-in. at 6 cts.

—Line "Y"—

2,700 ft. 10-in. at 10 cts.; 200 ft. 6-in. at 5 cts.; 545 ft. 6-in. at 5½ cts.; 100 ft. 6-in. at 5½ cts.; 100 ft. 8-in. at 7½ cts.

Alex. Larson, Wheaton, Ill.—

—John Wallace Branch—

2,300 ft. 10-in. at 12 cts.; 1,415 ft. 8-in. at 14 cts.; 1,500 ft. 8-in. at 15 cts.; 1,800 ft. 6-in. at 10 cts.

—McCue Connection—

425 ft. 6-in. at 8 cts.

—Line "Y"—

2,700 ft. 10-in. at 15c.

—Branch No. 1, Line "Y"—

200 ft. 6-in. at 7 cts.

—Branch No. 2, Line "Y"—

545 ft. 6 in. at 7½ cts.

—Newman Connection, Line "Y"—

100 ft. 6-in. at 7½ cts.

—Beckington Connection, Line "Y"—

ft. 8-in. at 8 cts.

. Wallace, Marengo, Ill., bid a lump sum of $250 on the 10-in., John Wallace branch.

Trade Notes

The general offices of The Pioneer Asphalt Co. of Chicago and Lawrenceville, Ill., are now at 7323 Woodlawn avenue, Chicago. The Company will continue to produce a full line of bituminous products of the highest quality and asphalts for every purpose. They will also continue to handle paints, pipe coatings, expansion joint, mineral rubber, insulation compound, filler, roofing cement, waterproofing and other bituminous products of like nature.

The Pacific Derrick & Hoist Co., 3223 First Avenue, South, Seattle, Wash., is the new name of The Burbank Machinery Co. The personnel of the Company remains the same. The new name is more indicative than the old of the specialty in service now being rendered.

The Kentucky Rock Asphalt Co., Louisville, Ky., are the successors in Kentucky of the Wadsworth Stone and Paving Co. of Lambert street, and P. R. R., Pittsburgh, Pa., asphalt and cement paving contractors.

After an existence of nine years as a department of the Chicago Pneumatic Tool Company, the motor truck interests of the company were on January 1st taken over by a new organization known as The Little Giant Truck Company. From small beginnings the motor truck department of the Tool Company had grown to such proportions that a separate organization to handle its many and varied interests became absolutely necessary—this growth was particularly marked during the past year. A good staff of active dealers eager to ally themselves with a twenty-five year old concern—a complete line of motor trucks from one to five tons capacity, the Duntley Gas Generator which permits the use of cheap fuels such as kerosene and distillate as an exclusive feature—have helped to build up the prestige of the Little Giant truck and to practically double the volume of business during 1917. The Little Giant Truck Company is owned and controlled by the Chicago Pneumatic Tool Company, and the officers are the same, W. O. Duntley, President; W. B. Seelig, Secretary; L. Beardsley, Treasurer; with T. J. Hudson, Sales Manager. The headquarters will remain in the Little Giant Building, 1615 Michigan avenue as heretofore.

There has been a consolidation of the Moline Automobile Company, makers of Moline-Knight motor cars and the Root & Van Dervoort Engineering Company into Root & Van Dervoort Engineering Company of East Moline, Illinois, an Illinois corporation. The officers and management remains the same and there is no change whatever other than in the name of the company. In the past these two companies have always been virtually synonymous, operating, however, under the two firm names under the control of the same general officers. For the season of 1918 the Root & Van Dervoort Engineering Company, in addition to building Moline-Knight automobiles, will have a big production of stationary engnes, tractor and automobile motors, besides filling large United States Government contracts. The Moline-Knight automobiles will be built in two chassis, one 40 H. P. and the other 50 H. P., known as the Models "C" and "G" respectively with prices running from $1,650 to $2,280.

The Concrete Mixing and Planing Co., Chicago, has removed its offices from 123 W. Madison street, to the First National Bank Bldg.

Personal Items

Alexander Potter, C. E., consulting engineer, 50 Church street, New York, has been engaged by the U. S. Government to act as consulting engineer in the design and construction of the sewerage, drainage and water supply systems for the new U. S. Government Explosive Plant, to be located near the Charlestown, W. Va., and upon which the government will expend some sixty millions of dollars.

Robert L. Fox, formerly of Johnstown, Pa., is the new city engineer of Bethlehem, Pa.

George H. Luther and James M. Homer have been appointed water commissioner and commissioner of public works, respectively, of Olean, N. Y.

W. L. Younce has been reappointed general superintendent of the New Castle, Ind., water and light plant. He has held this position since 1914.

Arnold B. MacStay has been appointed commissioner of the Department of Street Cleaning of the City of New York to succeed J. T. Fetherston. Mr. MacStay was formerly secretary of the department and later deputy commissioner. The salary of this position is $7,500 per annum.

C. A. Bingham has been appointed city manager of Waltham, Mass. He was formerly town manager of Norwood, Mass.

Geo. M. Comey, Wm. Ashley, A. M. Tower, Ellsworth Sherwood, Herman, Ludwig, Herbert A. Morean, Henry M. Toole, Adolph Gedeon, Wilson M. Grayell, Nicholas Gerten, Clayton Farris, E. S. Fairley, Ray Wilson, F. W. Truex and Joseph U. Sullivan, all former employes of the Lakewood Engineering Co., are now in the U. S. military service.

V. K. McBride, until recently advertising manager of the American Motor Truck Co. of Detroit, has been commissioned a captain in the ordnance department, with headquarters at Washington.

Otto F. Fitzpatrick, for seven years assistant city engineer at Crawfordsville, Ind., has been appointed city engineer at that place.

D. T. Pierce, for some years executive assistant of the Barber Asphalt Paving Co., Land Title Bldg., Philadelphia, Pa., is in France on a special mission for the American Red Cross.

Francis E. Daniels, assistant engineer with the Pennsylvania State Department of Health, is now captain in the Sanitary Corps, stationed at Camp Greene, Charlotte, N. C.

C. A. Rasmessen, formerly superintendent of the water and light department at Clay Center, Kans., has been appointed to a similar position in McPherson, Kans., to succeed Arthur Groesbeck, resigned.

Logan Waller Page, George H. Pride and Henry G. Shirley have been appointed members of the highway transport committee of the Council of National Defense. Mr. Page is director of the U. S. Department of Public Roads and Rural Engineering. He is a graduate of the Virginia Polytechnic Institute and also of Harvard University, class of 1893. Mr. Pride is president of the Heavy Haulage Co., of New York City. He is a graduate of Columbia University. Mr. Shirley is chief engineer of the Maryland State Roads Commission, Baltimore, Md. He is a graduate of the Virginia Military Institute, class of 1896, and has the degrees of C. E. and Dr. S. He was formerly with the New York Central and Hudson River Railroad, District of Columbia Engineering Department, Washington, D. C., assistant engineer with the Baltimore & Ohio Railroad, and county engineer for Baltimore county.

Waldo S. Coulter has opened offices as a consulting, designing and supervising engineer in the Engineering Building, New York. He was formerly a member of the engineering firm of Hansen & Coulter, dissolved.

Henry Beck has been appointed service director of Elyria, O. He was formerly engaged in the contracting business in that city.

Henry W. Klausman has been appointed city engineer of Indianapolis, Ind. He was city engineer of Indianapolis during Mayor Shanks administration and was county engineer from 1901 to 1910. The extensive sewage treatment experiments conducted in Indianapolis were under his direction. He succeeds Mr. Jeup.

Avery Thompson has been appointed city manager of Phoenix, Ariz., succeeding Robert A. Craig, who goes to Santa Barbara, Calif., in a similar capacity.

Catalog Reviews

The Monograph.—Illustrates and describes the Lanham Monograph for measuring flow of water or gases through mains or conduits, especially in water waste surveys. Issued by the Water Works Equipment Co., 50 Church St., New York. 6x9 ins.; 14 pp.

Hammer Pulverizer.—Illustrates and describes the K-B pulverizer, an all-steel hammer-mill for pulverizing moderately hard materials. 6x9 ins.; 20 pp. Issued by K-B Pulverizer Co., Inc., New York City.

Water Waste Detection.—Literature issued by The Pitometer Co., N. Y. Edison Bldg., New York City. The Cole Pitometer System; 6x9 ins.; 62 pp. Illustrates and describes the instruments used on water waste survey work and gives directions and tables. The Cole Recording Pitometer; 6x9 ins.; 12 pp. Illustrates and describes this instrument. The Cole Pitometer System—Instruments 6x9 ins.; 8 pp. Leaflets on Water Conservation by cities and reasons for use of Pitometer Pump Slip Indicator.

Montezuma Asphalt.—Issued by Warner-Quinlan Asphalt Co., 79 Wall St., New York City and Syracuse, N. Y. 8x11 ins.; 56 pp. Gives views showing contsruction of asphalt pavements and reproduces testimonial letters. Gives specifications met by this asphalt and other technical information on asphalt.

Water Works Tools and Supplies.—Literature issued by A. P. Smith Mfg. Co., East Orange, N. J. Illustrates and describes the following water works specialties: The "Kellogg" Removable Plug; Corporation Tapping Machine; Smith All-Pressures Valve; French Pipe Cutting Machine; Wood Water Meter Testing Machine; French Patent Lead Remover; Tapping Apparatus; Devices for Filling Sprinkling Wagons; Valve Inserting Machine; Calking Machine; Lead Melting Furnace; and, the Smith Hydrant.

Electro-Chemistry Applied to Sewage Disposal.—Issued by Electrotylic Purification Co., 15th St., and Lehigh Ave., Philadelphia, Pa. 6x9 ins.; 79 pp. Written by F. N. Moerk, Mem. Am. Electrochemical Soc., and Mem. Am. Chem. Soc. Sets forth in detail principles involved in treatment of sewage by electro-chemical process.

Hoist Tower Equipment.—Issued by Archer Iron Works, 34th Place and Western Ave., Chicago. Catalog No. 16; 6x9 ins.; 20 pp. Illustrates and describes full and varied line of hoist tower equipment for concreting.

Reinforced Concrete in Factory Construction.—Issued by The Atlas Portland Cement Co., 30 Broad St., New York. 6x9 ins.; 250 pp. A thoroughly technical discussion of textbook proportions. Fully illustrated. Illustrates and describes numerous reinforced concrete factory buildings

Cleaning of Water Mains.—Illustrates and describes apparatus and methods employed in the mechanical cleanin water mains. Issued by the National Water Main Clea Co., 50 Church St., New York. 6x9 ins.; 22 pp. Gives on cost and results.

Buckets and Wagon Loaders.—Issued by The Geo. Harris Mfg. Co., Inc., 141st St. and Rider Ave., New York City. Hais Digging Wagon Loaders; 6x9 ins.; 8 pp. Gives specifications, description and performance of this loader. Hais Buckets: 6x9 ins.; 8 pp. Illustrates and describes the design and operation of the contractor's bucket

EDITORIALS

1918 a Big Construction Year, After All

For the man in the construction watch tower there have been dark days in recent months. At times the outlook for construction in 1918 was not bright. Now the outlook is not merely fair, considering, not merely good, but decidedly good, and very likely to become better as the season advances.

The winter-time failure of the steam railroads has cleared the public view of the value of dependable highways. Highway enthusiasm reached its lowest ebb when the text of Priority Order No. 2 classed hard-surfaced roads with musical instruments and other things held unessential to winning the war. But Priority Order No. 2 is gone, let us hope never to return. Official Washington is not likely to "make the same mistake twice" with reference to good roads. From now on, every sign indicates, Washington will encourage road construction where it is considered essential to the military needs of the nation and where it is essential to facilitate the movement of commodities.

While the assertion that this is to be a big construction year is not predicated solely on the outlook for highway construction, that type of construction is so much in prospect that, standing alone, it would insure a busy year for the engineering construction industries.

It is stated on good authority that the federal government, the state governments and the counties will spend on highway improvement in 1918 the great sum of $263,096,610. This announcement is based on the first detailed survey of the nation's road-building plans as conducted by officials of the touring bureau of the B. F. Goodrich Rubber Company. These trained observers have been in daily contact for two months with the highway commissioners of the several states.

But is this such a large sum? It is. Everything is relative, and the significance of this great sum can best be appreciated by comparing it with the corresponding figures of other years. This sum exceeds by 82 per cent the expenditures for a similar purpose in any previous year. It exceeds the amount spent on highway improvements in 1917 by $118,797,750. And that is by no means all. Those in the best position to judge, the federal and state road officials, say this is only the least part of what should be spent for highway betterments before the end of the war, a war which it now appears is not likely to be a short one, reckoning time from the present.

Roads are coming to be appreciated as a vital part of the country's transportation system. They must supplement the steam railroads. Government officials calculate that, with good highways, motor trucks are capable of carrying approximately 200 per cent more freight than the railroads. The inexorable logic of the situation cannot be ignored or denied. The roads will be built.

But what of the labor situation? It is likely to be better than a year ago, for the reason that the man power of the nation is really being mobilized at last, not merely for fighting, but for all manner of productive enterprises behind the lines. Millions of adolescent youths who formerly whiled away the sunshiny days of summer in the pursuit of a baseball will turn their energies into productive channels this year. In general, idlers will catch the spirit of the times and get busy and workers will speed up.

But what of the expense? People are paraphrasing Farragut's "Damn the torpedoes! Go ahead!" They are not in a mood to hold back because of the increase in the cost of roads. They are beginning to understand that the higher cost is partly because of better construction, and also that costs were very low until recently and are not likely soon to be as low again.

And what of the attitude at Washington toward road construction this year? Good, and growing better each day. Just recently William G. McAdoo, Secretary of the Treasury and Director General of the Railroads, in a letter to Governor Charles H. Brough, of Arkansas, encouraged street and road building this year, and said there was no railroad embargo against the movement of material for this work.

So much for highways. When we turn to public utilities such as street railways, light, heat and power plants, water works systems, etc., we find Secretary McAdoo writing to President Wilson, urging that such privately owned utilities be granted higher rates to enable them "to meet alike the public requirements for service and the corporate financial needs upon which that service depends." He continued: "As Secretary of the Treasury I must take official notice of these matters. It is obvious that every part of our industrial and economic life should be maintained at its maximum strength in order that each may contribute in the fullest measure to the vigorous prosecution of the war. Our local public utilities must not be permitted to become weakened. The transportation of workers to and from our vital industries and the health and comfort of our citizens in their homes are dependent upon them." Certainly that statement proceeds from a man who favors the normal expansion of all public utilities during the war. Naturally, the same principles apply with regard to the normal extension, maintenance and operation of such utilities when publicly owned.

At no time has the government frowned on making an "urgently" needed public improvement. We shall not attempt to define the word urgent as used in this connection, but this much is very clear and of the utmost significance: The government now holds improvements urgent that it considered unessential but a few months ago, and even then was willing to approve many more projects than the public at the moment supposed.

All honor to the workers in the construction field who appreciated the vital relation between their activities and the national welfare, and who, despite the risk of being called selfish, were courageous enough to urge that construction work go on. Their point is sustained.

Better Pay for Railroad Civil Engineers Will Help All Civil Engineers

At the time of writing it is reported that the United States Government Railway Wage Commission looks with favor on the plea made in the interest of technical men employed by railroads that the Director General of Railroads be advised to increase the salaries of such men as well as of other underpaid men in the railway service. If such an increase in compensation is granted railway civil engineers it will naturally help all other civil engineers, as it will immediately raise the standard of compensation for engineering services. The benefit to the profession as a whole will vary directly as the rate of increase granted the railroad civil engineers.

For many years past the railroads have been the largest employers of civil engineers. The average engineer has had some railway engineering experience—many have had too much. In the fullness of his inexperience, and in an unguarded moment, the average civil engineering graduate has been pleased to accept a railroad job. He has kept the job for a period depending on several factors, prominent among which may be mentioned the rapidity of his rise in the organization, the rate at which he has acquired a working knowledge of business life, and the rate at which he has acquired what Bacon called "impediments to great enterprises, whether of virtue or of mischief," namely, a wife and children. Unquestionably the latter "hostages to fortune" have kept many a man working for the railroads after fear of punishment had gained the ascendency of hope of reward.

The civil engineer has served the railroads well. After acquiring expensive tastes and habits in college he has graduated to the railroad drafting room or surveying party, where he has found life long on service and short on reward for service. He has humped over the board for weary months and years on end, without catching a glimpse of the finger beckoning to advancement. He has meandered the face of the earth, laying out lines over which his fellow-men could travel in speed and comfort. He has sparred with mosquitoes with one hand and with the other dug "chiggers" from his quivering flesh; he has shivered in the cold blasts of the north or shifted from one burning foot to the other while standing behind a "gun" on the blazing turf of Oklahoma. He has marooned his family in a big-city flat while he lived in a rag house in the remote wilderness. He has liberated much love in his work and has had his greatest reward in knowledge of service rendered his country and his kind.

While the few railroad engineers have been well paid, the many have been cruelly exploited. The low wage paid him has fixed the standard for his brother engineers engaged in other lines. It will be nothing short of poetic justice if the railways, who were first in holding down the engineer, should be first in raising him to a higher plane of compensation.

Serving Our Field

The service rendered its field by MUNICIPAL ENGINEERING is most helpful to its large and rapidly expanding clientele of subscribers and advertisers.

The subscriber gladly pays the subscription price for the many original contributions expressly prepared for this publication by conspicuously successful workers in the field, and he is also given heaping measure in the form of service. The advertiser cheerfully pays the card rate for the opportunity of stating his proposition to the reader, but that is only the first element of value he receives in exchange for what he pays. He obtains service in addition and this co-operation is diverse in character and of high value.

To understand the nature of the service rendered the field, the field itself must first be appreciated. What is the field? This publication is edited primarily for those who are engaged in the design, construction, operation and maintenance of hard-surfaced roads in city and country, of water works systems, of sewerage systems, of water purification and sewage treatment plants, of refuse disposal plants, of bridges and buildings, and of drainage and irrigation systems. These works are constructed by companies specializing in these types of contracting and are designed by civil, or municipal and sanitary engineers in city, county, state or federal service, or in the employ of private corporations—this is the field in which MUNICIPAL ENGINEERING dominates. Its editorial pages tell the story.

This editorial scope, coupled with the editorial policy, not only holds a large and growing following among the leading engineers and contractors engaged on work paid for from public funds, but also among leading engineers, responsible contractors and alert plant superintendents engaged in the work of similar privately financed enterprises, such as telephone, gas, electric light, street railway and central heating utilities. It is a great privilege to serve the most influential men, the leaders, in this field.

Thus to a great extent this is a technical publication, but it is also a newspaper giving the latest construction news; the news in narrative form of big work coming up; the news of new machines, devices and materials; and all the essential news of the motor truck industry covering motor truck operation and accounting, the latest application of trucks, as in relieving railway congestion, the relative economy of truck and horse haulage, etc.

Too much emphasis cannot be placed on the fact that this publication is broader than its name. Originally it was called "Paving" when founded in 1890. It was founded to serve the needs of those engaged in street paving and has retained the lead in that field. Later the title was changed to "Paving and Municipal Engineering," but as paving is clearly included in the accepted meaning of municipal engineering it was dropped from the old to form the present title. Since that time the field of the publication has widened though the name has not changed.

Service to readers, in addition to what is given on the printed page consists of the giving of practical advice and information to individual correspondents on all matters pertaining to our field, of whatever nature. This service is rendered to the reader of a value many times greater than the nominal subscription fee which he pays.

The preparation of practical and attractive advertising copy is but the starting point in our service to advertisers, and there is no finishing point as the service is of indefinite extent. Aside from a special Daily Bulletin to all advertisers, letters giving hot tips on desirable selling connections and sales opportunities go out to advertisers in a steady stream. Many of our advertisers owe their selling connections and even the personnel of their sales forces to MUNICIPAL ENGINEERING, and "this co-operation in distribution" is invaluable.

PAVEMENT DESIGN AND CONSTRUCTION

Considerations Affecting the Design of Pavement Foundations

By H. J. Fixmer, Engineer Paving Division, Board of Local Improvements, Chicago, Ill.

In designing foundations for the various types of pavements we must consider the nature and preparation of the subgrade or natural foundation, the kind and weight of the possible traffic and the character of the wearing surface.

Pavements from the structural standpoint may be divided into two general classes. These are the monolithic and the compound construction. In the monolithic form the wearing surface is integral with the foundation, a mass or unit construction. In the compound form the wearing surface is composed of a yielding layer, a semi-monolithic layer or a rigid monolithic layer, superimposed on an artificial foundation, which in turn may be of a yielding nature or of a rigid nature.

The monolithic pavements (and roads) are compacted earth, sand-clay, oiled earth, gravel, water-bound macadam, cement, concrete and monolithic brick.

The compound pavements are bituminous macadam, bituminated concrete, asphaltic concrete, sheet asphalt, brick on a sand or mortar cushion, creosoted wood block, sandstone block, granite block and steel wheelways (car tracks).

Traffic

In designing any structure we must first of all consider what forces the structure must sustain. A pavement is a structure designed to accommodate the traffic using it in an economical, safe and efficient manner. We must know the kind and weight of the most destructive unit which will use or be permitted to use the pavement. The heavy, fast-moving auto truck with a maximum weight of from three to eight tons on a single wheel appears, at this time, to be the "force" we must design our pavement structures to resist. It may be possible to so regulate and route the traffic as to permit a lighter construction on local or inferior streets by prohibiting travel on any such street by any vehicle exerting more than one or two tons on a single wheel. Until such regulation is established by a proper consideration of the economic factors involved, we must design our pavement structure throughout to meet the exacting conditions of modern commercial traffic.

Subgrade

It may be safely stated as an economic proposition that the maximum strength of the subgrade should be developed before placing any type of pavement upon it. The subgrade, together with its drainage system, should be a permanent construction. To this end particular attention should be given to securing a subgrade of as near uniform maximum strength as possible. From an engineering standpoint, if the subgrade is to be prepared in such manner that it will be permanent, it is imperative that the top surface be located at a grade or elevation that can be maintained far into the future. For this reason it is considered desirable, particularly in city streets, deliberately to locate the subgrade surface from 2 to 6 ins. below the normal elevation. This can be done with a proper design without inconveniencing either the vehicle or pedestrian traffic. This provision will permit strengthening the foundation later on by the addition of an extra layer, or permit resurfacing with a deeper and more durable surface.

The material of a subgrade consists of a porous, semi-porous or an impermeable earth. It varies, often on a single construction, from deep sand to compact clay. On the typical country road the drainage is taken care of by the deep side ditches and drain connections to open water courses. As a rule the road is built on a fill, and even where cuts are encountered the longitudinal grade, with side gutters, takes adequate care of the surface water. In urban districts, however, the pavement is invariably constructed in cut or below the established surface of the adjacent ground.

Side Drains

Particular attention must be given to keep the subgrade free from water, for water destroys the uniformity of clay subgrade by softening, facilitating movement and by freezing, causing expansion. Where a permanent waterproof wearing surface is used the water can pentrate into the subgrade only from under the curb or along the gutter face of the curb where the curb and pavement have separated. It is obvious, therefore, that the water should be intercepted and collected by some type of drain or channel under or adjacent the curb. Where the soil is porous and the waterplane is ordinarily at least 2 ft. below the surface of the subgrade no provision for drainage is required except at sumps or changes in the character of the soil structure. In mixed or clay soils provision should be made to carry away the water. This is done by laying a tile drain or a "blind drain" composed of a layer of gravel, stone, coarse cinders or coarse sand from 3 to 24 ins. deep and about 1 ft. wide and connecting the drain at intervals with a catch basin, built to take care of the surface drainage, or to a sewer inlet. The depth and size of the drain will be determined by the porosity of the soil and the probable amount of water to be removed.

The subgrade must be properly and uniformly compacted. This is done by careful rolling with a heavy roller, except where the soil is sand.

Backfilling Trenches

The manner of backfilling trenches and excavations for manholes and other underground structures should be given particular attention. In sandy soils the surface and all openings and depressions can be compacted by judicious application of water. In clay and similar soils care must be exercised to provide against any initial or progressive settlement. Where the depth of the trench is less than the width of the trench below the subgrade surface it should be backfilled with sand or other readily compacted material. Likewise, all excess openings around catch basins and manholes should be filled in with sand or material which will settle by flooding. Deep trenches should be tamped and flooded. The tamping should be more rigorous adjacent the sides of the trench for a distance above the pipe or conduit equal to the width of the trench. This method of tamping tends to reduce the pressure on the underlying pipe and creates an arching effect in the earth structure, which contributes to the stability of the trench backfill. If possible, a disturbed subgrade should be allowed to settle for a year before building the pavement.

Oiling Subgrade

As a factor of safety against the inaction or inefficiency of the side drains along the curb, it might prove both wise and economical to render the subgrade waterproof, water repellant and more compact. In my opinion, the ideal method of securing a crust having the maximum degree of compression and water tightness is to loosen the upper 4 to 6 ins.

of the subgrade surface, harrow it, apply from one half to one gallon of asphalt oil or bituminous cement per square foot and roll with a roller having projecting or "sheep's foot" tampers. The surface should be finished smooth and parallel with the contour of the finished pavement.

Artificial Foundation or Base

There are, apart from the monolithic types of pavement previously mentioned, four general types of pavement foundations. These are, the Telford, or hand-set stone; macadam, either new construction or old macadam reshaped; concrete, either new or old monolithic concrete badly worn, and old block pavement suitable as to surface and grade.

The main purpose of the artificial foundation is to support the wearing surface uniformly and transmit all traffic pressure to the subgrade below. On a uniform subgrade it should be of uniform strength or thickness. Where weak places exist in the subgrade and can not otherwise be remedied, the foundation must be proportioned to equalize these defects. To do this will require a radical change in the customary application. Instead of providing for a base of constant thickness or standard composition, it will be necessary to state the limits or variations and provide for bidding on a cubic yard basis rather than the customary square yard basis.

An old block pavement, because of the established grade and its slight unevenness, is suitable if the traffic is light for resurfacing with an asphalt top on a binder course. As a rule, the traffic is too heavy, in which case the wearing surface is removed and the base alone utilized. Practically all new construction is placed on a macadam or concrete base. Both these types of base have an affinity for water. Macadam through absorption and capillarity tends to keep wet. Concrete absorbs water from above as well as below. Recent observation in buildings indicated that concrete weakens and slightly but progressively disintegrates where kept more or less moist. In view of this fact, where permanent construction is planned for, it might be well to give more thought to waterproofing the subgrade by the application of oil as previously suggested. In determining the thickness and composition of the macadam or concrete base we must know the traffic weight to be sustained and the permissible weight the subgrade can safely support. The matter of thickness, richness of mix and need of reinforcing as applied to a concrete pavement is an economic problem. Strength in concrete can be secured in these three ways or by a combination of these features. In the case of macadam strength can only be secured by increasing the thickness, assuming, of course, a good material properly consolidated.

Wearing Surface

In all cases provision must be made for a wearing course of uniform thickness in order to secure uniform wear and reduce the amount of maintenance. Whether the wearing surface is of a yielding nature or of solid monolithic construction, its strength as part of the foundation should, as a rule, be ignored. This is rational in view of the effect of wear, possibility of replacing with another type of surface and disturbance of continuity due to underground repairs. The combination of a given type of base with a given type of wearing surface together with the condition of the subgrade requires study. Heavy traffic generally requires a rigid base. A yielding wearing surface may employ a yielding base where the traffic is light and mostly horse drawn. Concrete bases vary from 4 to 8 ins.; macadam from 4 to 12 ins. It is an economic problem to determine the best construction. The factors of first cost, available materials, maintenance and public convenience must be duly considered. Under prevailing conditions it may be advisable to spend more on developing the strength of the subgrade than increasing the strength of the artificial foundation. Investigation, experiment and science are necessary in evolving the efficient structure for a given location and a definite traffic stress.

Construction Plant and Methods Employed in Building Concrete Roads in Wayne County, Mich.

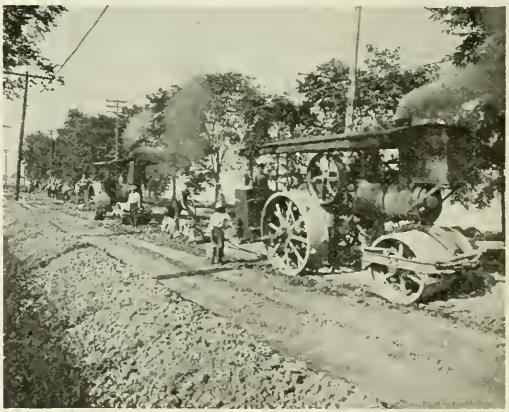
The construction of concrete roads in Wayne County (Detroit), Michigan, has developed to a point where the procedure employed is the best obtainable both from the standpoints of results secured and expense incurred a description of the methods employed, as promulgated by the Board of Commissioners, forms an important chapter in the classic literature of American highway engineering.

Preparing Subgrade

After the road has been staked out and as soon as the weather will permit in the spring, the subgrade is prepared and shaped. The major position of such work is done with scarifiers and graders, the hauling power for which is furnished by steam tractors or rollers. Careful attention is given the grade to eliminate soft, spongy places and a 10-ton roller is used to roll it hard. To produce a good concrete road, thorough drainage is necessary in addition to a good subgrade. Both proper grade and drainage are difficult to cope with in Wayne county, as the county, for the most part, is flat and situated in a valley not easily drained. The subsoil is largely of heavy, sticky clay, with some loose, deep sand.

Using Industrial Railway on Long Hauls

The great problem has been in getting the materials on the subgrade, and various plans are followed on the different roads, due to varying conditions. On long hauls an industrial railway is used to transport all materials from the point of



IN PREPARING THE GRADE FOR CONCRETE ROADS IN WAYNE COUNTY, MICH., MACHINERY IS USED WHENEVER POSSIBLE.

receipt to the point of construction, consisting of one or more 7-ton, 30-h.p. locomotives, 60 or more 1,000-lb., double-side, V-shaped steel dump cars, each of 1½ yds. capacity, and 8 16-ft. flat cars, all of 2-ft. gage. The track is furnished in built-up units, 15 ft. in length, consisting of steel rails fastened to steel ties. A turnout may be laid wherever needed by replacing a section of track by a switch or curve, as this is also furnished in 15 ft. lengths and of such radius that locomotive and cars will readily pass through.

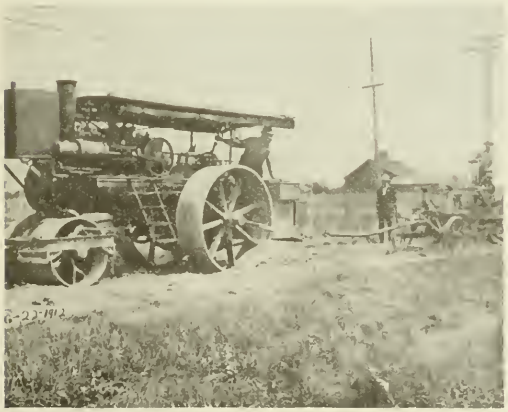
Of course, it is not necessary to turn the engine around, as it pushes as well as pulls the load. The average train consists of 30 loaded cars, on a level road, and 9 only where the grade is 6%, though as many as 42 cars have been hauled.

Unloading and Piling Materials.

Materials for the work begin to arrive before actual concreting is in progress. These are immediately unloaded by a

clamshell bucket and thrown into stock piles. After concreting has been in progress, the materials are unloaded directly from the railroad cars to the steel dump cars and transported to place. The unloading crew consists of four laborers, an engineer, and team and teamster. The team hauls seven loaded cars to the siding where trains of 30 cars are made up. Whenever shipments are delayed the stock pile is resorted to for materials. Work usually is started at the end farthest away from the railroad switch. Five miles per hour is the average set speed, including time for coaling and watering. The actual running speed en route is from 6 to 8 miles per hour.

There is no danger of dumped materials falling back upon the track, as the center of the pile is about 3 ft. from the edge of the nearest rail. Two men are able to tip a loaded car body. Materials are readily measured in the cars and distributed along the road at such intervals as best to meet



GRADING BEHIND AN ENGINE ALSO SERVES TO ROLL THE SUB-GRADE. WAYNE COUNTY, MICH., CONCRETE ROAD CONSTRUCTION.

the requirements of the mixer. The aggregates are loaded into the dump cars, the cement in any available cars, and expansion plates, asphalt filler and other necessities on the flat cars. Coal for the mixer is likewise brought to the site over the railway. As concreting progresses the haul becomes shorter and the track is taken up. These rail sections are transported to the loading point on the return trips of the train.

Industrial Railway Gives Satisfaction.

The tracks for the industrial railway can be laid on any surface over which transportation of any kind is at all possible. Rainy weather and muddy roads do not impair the efficiency of rail haulage, nor is the load too heavy for the ordinary highway bridge. A factor of much importance is that very little hauling space is required. When necessary the track can be laid on the berm of the road, so that it is possible to haul material either in the same direction as the concreting is proceeding or else in the opposition direction. The railway, too, is practically independent of labor conditions, as one engineer, a fireman, and two or more brakemen make up the entire crew. Although the unit rail sections provide an easy method of crossing highways and steam and electric lines, and the clearing of these when necessary by removing the rail sections, it is not always possible to obtain permission to make such crossings.

Where the use of an industrial railroad is not feasible teams are used for hauling. Teams work economically on short distances, but weather conditions at times are a handicap, and at certain seasons of the year the demand is so great for them generally that they are difficult to secure.

Distributing Materials

One man on the grade has charge of the dumping of material and he is furnished with a table of materials to be placed per 100 ft. stations, in order that the material may be properly placed to minimize rehandling.

The foreman in charge of the yard is also furnished with a table of quantities showing amounts required on different widths of roads so as to avoid surplusage at a given point.

Stock piles are also established in the fall at various unloading points so that breakdowns, car shortages, intermittent or irregular deliveries will not interfere with the work after getting under way in the spring.

During the past year long hauls have been encountered

SPRINKLING SUB-GRADE PREPARATORY TO PLACING CONCRETE

very generally. On the Seven Mile Road the farthest point of haulage was over nine miles; on the Mack Road the farthest point of haulage was about seven miles.

Water Supply.

The transportation of water, of which large quantities are used in mixing and curing concrete, and supplying the mechanical equipment, such as concrete mixers, traction engines, road rollers, etc., has often been a serious problem. It has been solved by laying 2-in. pipe along the road from the nearest source of supply, and pumping the water along the route, either by gasoline engines or electric motors. Water has been pumped a distance of 10 miles, the nearest source of supply, and water piped from the water works system of Detroit, Northville and other cities and villages.

Road Design.

The standard width is now concrete 18 ft. wide with a minimum width over all of 28 ft. The concrete is 6 in. thick at the sides and 8¼ in. thick in the center, built on a flat subgrade. Six inch channels 12 ft. long are used instead of wooden forms along the side. As these forms are subsequently used to support the templet and bridge from which the finishers work, great care is exercised to get them true and rigid. Expansion joints consisting of asphalted felt (about ½ in.), inserted between two Baker Armor Plates, are placed in the road 25 ft. apart.

Concrete Mixing.

A concrete mixer which travels under its own power is

used, from which a 20-ft. boom projects, which swings over a 180-degree arc. The dumping bucket is carried out on this boom under power, and eliminates much hand labor. One batch consists of three sacks of Portland cement, 4½ ft. of sand and 9 ft. of pebbles. The specification that the batch

LOADING INDUSTRIAL CARS WITH CLAMSHELL.

shall receive 16 complete revolutions and remain in the mixer for one minute is resulting in producing an excellent quality of concrete. Batches are discharged at intervals of about two minutes. The 10-hour working day is observed.

Concreting Materials.

Before any concrete is placed, in order to prevent absorption of the water from the mixed material, the subgrade is thoroughly wet down. The mix is fairly wet and of such consistency that men working in the concrete sink 4 or 5 in.

HAULING CEMENT UP 6 PER CENT. GRADE ON INDUSTRIAL RAILROAD.

Clean material is an absolute requisite to securing good concrete. The pebbles are washed and screened so as to be free from loam, clay and other foreign substances. They range from ¼ to 1½ in. and are so graded as to reduce the voids to a minimum. The sand is bank sand, washed and screened, free from loam, clay, etc., and ranges in size from ¼ in. to dust, with the coarser particles predominating. The bulk of the coarse and fine aggregates are shipped in from outside points on account of their scarcity locally.

Placing Concrete.

When the mixer is close to the stock piles, congestion is avoided by having six men load the barrows and six men wheel the materials to the skip. Wheelers and shovelers alternate in their work for each successive block of concrete, a scheme that has proved efficient, because the variety of work tends to prevent its becoming monotonous. When the stock piles are a relatively great distance from the mixer, each of the twelve material men loads and wheels his own barrow, so that a continuous stream of material is always en route.

Use of Templet

The concrete is brought to grade and shape by the use of a templet. This templet or strike board is made of 2-in. plank, preferably in a single piece, the curvature of the under edge being made to conform exactly to the finished surface of the concrete road, which is crowned approximately ¼ in. to the foot. On each side of each end is an iron handle for drawing the strike back and forth. The curved edge is shod with 1-in. angle irons bent to the curvature of the strike, giving it a metal wearing surface. The length of the strike exceeds the width of the road metal by 1 ft. A 12-in. plank is suitable for widths of road metal up to 18 ft. If the road is wider than this, a built-up form of strike is necessary, which is trussed to prevent a sag or flattening of the crown. The strikeboard is sawed back and forth on the side rails, and moved slightly forward at each stroke, giving the concrete its initial shape. After this operation no workman is permitted to disturb the concrete in any way either by stepping in it or by throwing anything upon it. This rule is imperative, as a violation of it means a road with waves and depressions by causing the neat cement and finer particles to rise to the top. The aim is to have the stone take the wear, as it is the hardest part of the aggregate.

Finishing

The final finishing up of the road is done by two men whom we term "floaters," who work from a bridge which

MATERIALS SPACED ON GRADE READY FOR MIXER.

rests on the side rails, having no actual contact with the concrete. A wooden trowel of home manufacture is used for this purpose. The use of a trowel of this nature prevents the road from becoming slippery.

One crew used a finishing machine during the entire season, for shaping and finishing the road, with very satisfactory results as regards the quality of work produced, but up to date the cost has been greater. The better results secured

in eliminating depressions and irregularities, however, justifies this small increase in cost and the board will undoubtedly add this device to their standard mechanical equipment.

Curing Concrete

When the concrete will stand of its own weight, the side rails are removed. Each day's work is finished up to an ex-

FINISHING MACHINE STRIKING OFF, FLOATING, LEVELING AND FINISHING SURFACE ON AN 18-FT. WAYNE COUNTY CONCRETE ROAD.

pansion joint, and no more than 20 minutes is permitted to elapse between batches during the day. The day following the laying of the concrete it is covered with a couple of inches of sand or loose soil such as is available and is sprinkled during the day for two weeks. This prevents the road from drying out and is an important factor in properly curing the concrete so that it will attain its maximum hard-

FINAL FINISHING WITH A CANVAS BELT ON WAYNE COUNTY CONCRETE ROADS.

ness and strength. Plenty of water after initial set has taken place is vitally essential in producing good concrete. The finished road is sprinkled continuously for at least two weeks.

Roads are not opened for traffic until from four to six weeks have elapsed after the last batch of concrete is laid; the length of time depends upon the season of the year, as concrete sets up much more slowly in cold weather than when it is hot and dry.

Shoulders of earth or crushed stone or gravel, are built 3 to 4 ft. wide on each side of the concrete. This work is not started until after the road is at least four weeks old.

During the past year most of the work has been carried on well away from towns where suitable quarters could not be obtained for the men, so sleeping and eating quarters in tents along the road were provided. The men obtain food from the nearest town and cook their own meals, while the water supply for the roads, usually serves as well for the men. The mixer crew's quarters are kept at sites a convenient walking distance from the work, and the men unloading and transporting materials live in tents pitched close to the railroad siding.

Three concreting crews were maintained in the field during the past summer (1917), and to each of these crews is attached a grading crew, a shouldering and ditching crew, an unloading outfit and a culvert crew. All work is specialized and machinery is used wherever possible, since man and horse labor are scarce and expensive in the country districts during the road building season.

Using Home-Made Equipment on a Small Monolithic Brick Pavement Construction Job

By Fred R. Charles, Civil Engineer, Richmond, Ind.

One of the modern practices in brick paving is to make the wearing surface integral with the foundation, either by laying the brick directly on the fresh concrete or on a cement-sand cushion.

This method does not tolerate slipshod ways, but requires the very best. The former often creep in without the intent of the contractor to slight his work or "skin the job"; in fact they may easily cost him more than better methods, and come in merely through lack of watchfulness on his part or the carelessness of his men.

A street, recently built, illustrates the building of a monolithic pavement by the use of home-made equipment, and without elaborate and expensive appliances, as the job was too small to justify the expense of the latter; the contractor not being already provided with them.

The Templets

Two widths were necessary, 20 and 26 ft.; requiring two lengths of templets or "cut offs", which were made at a local planing mill of six 1-in. planks spiked together, and cut to the proper crown and notched at the ends to ride on the concrete gutters, as the combined curb and gutter with 12-in. apron was built first.

At each end of the templets runners at right angles thereto, shod with iron to prevent wear, rode the gutters and tended to keep the templet vertical. Sometimes the templet is attached to the traction mixer and is drawn when the latter moves, but in this case it was pulled by from 4 to 8 men, depending on the width and the stiffness of the concrete. Usually 2 or 3 repetitions were required to bring the concrete to the proper level.

After the passing of this first templet, a dry mixture, composed of one part cement to two parts sand, was spread on the surface and a second templet drawn over it. This templet was made to cut about ⅛ in. higher than the first, and its effect was merely to fill in the rough places and cover the concrete with a slight film of dry mortar, about like war butter on war bread.

Directly upon this the brick were laid in first-class manner, as usually specified; rolled immediately and grouted within 30 minutes.

Consistency of Concrete Mix

In mixing concrete for base, it was found necessary to use

care to guage rightly the amount of water. A little too dry would make the templet hard to draw, and leave a rough surface, while a little too wet would cause a soft spot in the foundation, allowing the brick to settle too much when rolled, and causing an uneven surface. So the concrete must not be too wet nor too dry, but must be "just right". The amount of water in the gravel aggregrate after washing or after a rain, or after several days sunshine is a variable quantity, and it requires considerable vigilance to see that the right amount is added at the mixer, for a uniform consistency is essential.

Hand Rolling

After laying and inspecting the brick, which latter should be done as much as possible before laying, in order to avoid disturbance of the bed by removal after laying, the rolling was done by a hand roller, filled with water to furnish the weight. One man could handle this roller, but usually two were put at it to obtain better speed. Rolling was first done longitudinally, beginning at the gutter and working up to the center, then at the other gutter, to the center, then across the street; then at an angle of 45 deg., both ways, making a letter "X". This generally ironed it to a smooth surface, but if not, rolling was continued until so secured.

Grouting

As soon as possible, after rolling, the grouting was done in the usual way; mixing by hand in the standard boxes; using care to obtain thorough mixing and applying without separation of the ingredients; thoroughly filling the joints by repeated brushing and squeegeeing; repeating as often as necessary to fill the joints completely after settlement.

In operation, the men wheeling concrete were utilized to draw the templet as they could easily do this and still keep ahead of the brick layer with the foundation. One additional man took care of spreading the dry mortar and shaping it with the "lute" where needed, such as at street intersections, where the regular cut-off would not work. On narrow intersections, a man with a good eye could do it properly, but on wide ones, stakes were set at close intervals by the engineer.

Two men could roll, and then help the others on the grouting. Taking it altogether a very satisfactory pavement was obtained, with a fair profit to the contractor.

Bumps and Waves in Bituminous Sheet Pavements

By W. L. Hempelman, Pioneer Asphalt Co., Chicago, Ill.

The present contribution was inspired by reading the article by Mr. Lester Kirschbraun, in Municipal Engineering for March, 1918. On page 104 he shows graphically temperatures at various depths in a bituminous mixture with a constant surface temperature of 150 deg. Fahr. for five hours.

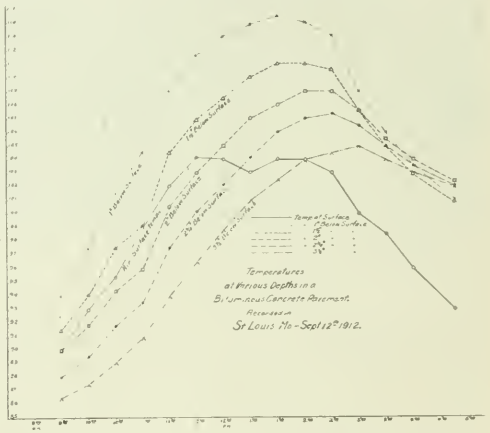
The data here given are not newly observed. In fact, they were compiled several years ago, but, in the writer's opinion, the theory here suggested, if it may be called a theory, holds now as well as it did then.

Many, many sound reasons have been enumerated in explaining the "waving" or "pushing" of bituminous sheet pavements. In specific cases frequently one primary cause has been given, the same leading to minor allied reasons, any one or combination of which might explain the particular condition under consideration.

St. Louis Conditions

As engineer of bituminous pavements for the city of St. Louis the writer had the opportunity of observing many different types of pavements as well as pavements constructed by different contractors with different bituminous materials. It was with the idea of determining if possible a condition which prevails in all bituminous pavements in a particular locality that the observations tabulated and platted herewith were made.

It was thought that, everything else being equal (the mixture, raking, depth, compression, density, etc.), there might be a sufficient difference in temperature between successive (imaginary) layers, meaning at different depths from the surface in contact with the wheel of the passing vehicle, as to result in a material change in the consistency of the asphaltic or tar binding cement for these various depths. What follows particularly applies under climatic conditions such as obtain in Missouri and other states of the central Mississippi valley. It is not uncommon in this section to experience a dry, hot spell of from five to eight weeks, during which period the atmospheric temperature may not fall below 80 deg. In other words, there is not a marked cooling off of the atmosphere with sundown, and hence the pavements do not cool to the same extent for their entire depth, as in other localities, all of which means the pavement tends to remain soft or plastic, due to the softening or change in consistency of the bituminous cement.



TEMPERATURES OBSERVED AT VARIOUS DEPTHS IN A BITUMINOUS CONCRETE PAVEMENT FROM 9:30 A. M. TO 4:45 P. M.

Temperature Variations

We all know that during the hot summer months properly

TABLE 1—TEMPERATURES AT DIFFERENT DEPTHS IN BITUMINOUS CONCRETE PAVEMENT (BITULITHIC).
(Observed in Grand Ave., just South of Meramec St., St. Louis, Mo., September 12, 1912.)

Time	Air—°F	Depth of 1 in.—°F	1½ in.—°F	2 in.—°F	2¾ in.—°F	3½ in.—°F	Remarks
9:30 A. M.	90	94	91.5	90	88	86.5	Clear
10:00 A. M.	93	97.5	94.2	91.8	89.5	87.5	Clear
10:30 A. M.	95.4	101.5	97.5	94.3	91.8	89.2	Clear
11:00 A. M.	99	104	99.2	96	93.5	91	Clear
11:30 A. M.	102	109	104.5	100.5	97.5	94	Clear
12:00 N.	104.3	111.2	106.8	103	100.2	96.5	Clear
12:30 P. M.	104	113	108.5	105	102.2	98.8	Clear
1:00 P. M.	103	113.8	110	107	104.2	101	Clear
1:30 P. M.	104	114.5	111	108	106	102.5	Clear
2:00 P. M.	104	114	111	109	107	104	Clear
2:30 P. M.	103	113.2	110.6	109	107.3	104.5	Slightly hazy
3:00 P. M.	100	109.2	107.6	107.5	106.5	105	Slightly hazy
3:30 P. M.	98.5	106	105.0	105.5	105	104	Slightly hazy
4:00 P. M.	96	103.5	102.8	104	103.5	103	Quite hazy
4:45 P. M.	93	101	100.8	102.3	102	102	Quite hazy, few clouds

TABLE II—TEMPERATURES AT DIFFERENT DEPTHS IN SHEET ASPHALT PAVEMENT
(Observed in E. S. Kingshighway, North of Berlin Ave., St. Louis, Mo., September 4, 1912.)

Time	Air—°F	Depth of 7/8 in.—°F	1 3/8 in.—°F	2 1/4 in.—°F	3 1/8 in.—°F	4 in.—°F	Remarks
10:00 A. M.	88	86	86	86	84.5	85	In shade until 11:00 A. M.
11:00 A. M.	91	90.3	89	87.8	85.5	85.5	Clear
11:30 A. M.	99	102	98	93.6	88.6	87.2	Clear
12:00 N.	101	106.5	104.3	99.5	92	89.5	Clear
12:30 P. M.	103.2	111	108.2	103.6	96.7	93	Clear
1:00 P. M.	104	116	112.8	107.2	100	96	Cloudy from 1:00 to 1:40 P. M.
1:30 P. M.	101.3	114.2	112	108.5	102.2	98	Cloudy
2:00 P. M.	104.5	116	112	109	103	99.2	Passing clouds
2:30 P. M.	108	117	114.5	110.6	104.8	100.5	Clear
3:00 P. M.	106	117	115.5	112.2	106.5	102.2	Clear
3:30 P. M.	104.5	115	114.5	112.5	107.3	103.5	Clear
4:00 P. M.	101.6	113	103.4	112	107.3	104	Clear
4:30 P. M.	97	106	108.5	108.5	106	104	In tree shadow at 4:15 P. M.
5:00 P. M.	97	104	106	106.2	104.4	103	Shade

constructed bituminous pavements will be marked by caulks of horses' shoes. The common thought as expressed by an asphalt foreman laying a street is that "if it does not mark in summer it will probably crack in winter." The desirable pavement, traffic, climatic and local conditions considered, is that pavement which will not become objectionably soft in summer, and thereby materially add to the tractive effort necessary to move a given load over it, and will not become glassy hard in winter, resulting in a dangerous, slippery pavement. Consider the possible temperature variation of such a pavement, say, for St. Louis conditions. On the surface of an asphalt pavement in St. Louis we have recorded a temperature of 142 deg. F. and in less than six months a temperature of 4 below zero. The loads carried by these pavements, the impact of the horses' shoes, etc., were the same for both temperature conditions. With a possible temperature variation of approximately 145 deg. we were frequently asked in St. Louis why the pavements were not constructed so they would not mark in summer.

One particularly hot afternoon in August, in St. Louis, a thermometer with the bulb just covered with asphalt lying on the top of a barrel of asphalt reached a temperature of 152 deg. F.

Method of Taking Temperature

In recording these temperatures a word should be said concerning the method employed in obtaining the data. Holes were drilled in the bituminous pavement and thermometers inserted, depths indicated being the distance the end of the thermometer penetrated below the surface of the pavement. A mixture consisting of sand and a heavy flux oil was packed about the thermometer from the bottom of the opening to the pavement surface. As indicated, readings were taken every 30 minutes for a period of 7 hours. To the right, under remarks, we attempted to describe the atmospheric conditions at the time reading was taken. As was expected, we found the atmospheric temperature in the morning to be considerably higher than at any material depth in the pavement, which condition, it will be noted, entirely reversed itself by 5:00 p. m. The platted results most clearly show this.

Conclusion

With the difference in temperature for the different depths, as indicated, it would seem that the change in consistency of the asphaltic cement for these different depths might easily permit the shifting of the wearing surface material on itself. This would particularly obtain where the bituminous cement used was of a susceptible nature—that is, a material which changes decidedly in consistency for slight changes in temperature.

Only Table I has been represented graphically, since from the recorded data it will be seen that the curves for Table II would be very similar.

As might be expected, the maximum temperature reached for any depth becomes later in the day as the depth increases. It will be interesting to note that while the highest atmospheric temperature in the sun was 106 F., in Table II this temperature is exceeded by the maximum temperature for the various depths, the temperature for 7/8 in. below the surface reaching 117 F. To the writer it seems the bituminous pavement assimilates heat during the day, part or all of which heat is lost during the night. The temperature at any depth in the pavement in the morning will depend upon the atmospheric temperature change which has taken place and the condition of the air, whether quiet or windy.

Recommended Procedure in the Construction of Wood Block Pavements

By Lambert T. Ericson, Assoc. Mem. Am. Soc. C. E., Contracting Engineer, The Jennison-Wright Company, Toledo, Ohio, The Midland Creosoting Company, Granite City, Ill.

There has been a decided movement on foot during the past year to eliminate sand and dry mortar cushions in creosoted wood block pavements. This plan has been extensively tried out and has proven a decided improvement over the methods formerly employed and will undoubtedly result in the prolonged life of the pavement involved.

Omission of Cushion

The methods pursued consist in finishing the concrete base with a smooth and even surface, exactly conforming to the contour of the finished grade and exactly the depth of the blocks below it. This can be accomplished, in most cases without extra expense, by the use of long-handled wooden floats or similar devices. The concrete base is then covered with a thin and even coating of coal tar pitch, which is permitted to harden before the blocks are laid upon it.

Necessity of Bituminous Fillers

Mr. Teasdale, of the Forest Service Laboratory, in an exhaustive report to the committee on "Service Tests of Creosoted Wood Block Paving," of the American Wood Preservers' Association, at their convention in Chicago in January, gave positive proof of the necessity of bituminous fillers being used and the desirability of a firm and unyielding base being provided; that success may be had with either coal tar paving oils or pure coal tar distillate oils, the essential point being that the treatment should be thorough and properly carried out. These facts have been borne out by experience in all parts of this country. The combination of sand cushions and sand fillers has always been disastrous. Proper construction methods in combination with thorough treatment will result in uniformly good work, regardless of the grade of preservative oil used.

The substitution of dry mortar for plain sand in the cushions was a decided advance, but even with that type of construction the result desired—namely, the elimination of shifting—is not always attained, on account of the frequent failure of the cement properly to set up. The full preparation of the base, in plain sight, before the blocks are placed in position, is a sure preventive of this evil, and also eliminates the possibility of pockets of water forming underneath the pavement.

Omission of Cushion Minimizes Adverse Weather Effects During Construction

Another decided point in favor of the elimination of the

cushion, from the construction standpoint, is the facility which it affords for construction to proceed in unfavorable weather conditions. Sudden rainstorms very often wash out and destroy uncompleted sections of pavements where cushions are used, and it is impossible to proceed if the weather is at all unfavorable. At the end of a season a hold-up of that kind incurs endless hardships both to the contractors and the community. The accompanying view shows paving being installed on Stickney avenue, in Toledo, Ohio, during the past winter, directly after a snowstorm. The concrete base was all prepared in this case and part of it was coated with pitch before

STEAMING SNOW FROM WOOD BLOCKS BEFORE APPLYING PITCH FILLER, TOLEDO, OHIO.

the snow came; part of the blocks had been laid, but the pitch filler had not been introduced. It was only necessary to clear the snow off with live steam in order to enable the construction to proceed with full speed and efficiency.

Function of Bituminous Filler

The necessity of a bituminous filler is just as essential for success as a substantial base. It is necessary to seal the joints to prevent water getting underneath, to cement the blocks together and to provide expansion joints between the individual blocks. In order to be sure that the filler penetrates to the full depth of the blocks and to provide a means for the prevention of buckling due to expansion, it is further necessary to adopt an open joint form of construction.

Open Joint Construction

The open joint form of construction requires that the blocks be provided with automatic means of separation, which will assure them being separated exactly the predetermined distance apart and at the same time be held firmly in that position. This separation should not be less than ⅛ in. on the sides and 3/16 in. on the ends.

Applying the Filler

Care must be taken in applying the bituminous filler that the joints be not filled completely to the top with pitch. The top inch should be filled with sharp sand. If the joints are filled flush with pitch, the subsequent expansion of the blocks will cause an obnoxious condition on the surface similar to bleeding of the oil.

Coal tar pitch is preferable to asphalt for use as a filler, since it amalgamates perfectly with creosote oil, while asphalt does not. The pitch should have a high melting point, preferably between 145 deg. F. and 155 deg. F. When of that consistency the residue left on top will chip and wear off very quickly with the traffic. Furthermore, the creosote oil in the blocks will cut the pitch back sufficiently in the joints to prevent it becoming brittle. It should be flushed into the joints at a boiling temperature, using a rubber-edged or heated metal squeegee. When this procedure is properly carried out, the film left on top is negligible. The pitch in the joints, flushed full while hot, will settle the desired inch from the top when it cools down.

The pavement should then be covered with sharp sand and kept so covered, under traffic, for a period of six or eight weeks. If bleeding conditions should develop at any later date it should be given another coating of sand.

Specified Open Joint Construction

The open joint form of construction is now being exclusively specified by a great many cities, among which are Cincinnati, Milwaukee, Toledo, Toronto, Nashville, New Orleans and Cleveland. Mr. E. W. Stern, chief engineer highways, borough of Manhattan, New York City, Mr. Walter Buehler and several other engineers discussed the merits of this type of construction and its necessity in order to avoid the evils of buckling, in the April, 1917, Proceedings of the American Society of Civil Engineers, pages 788 to 798. When it is properly carried out it is a sure cure for buckling, bleeding and excessive slipperiness.

WATER WORKS MAINTENANCE AND OPERATION

Practical Measures for Securing Greatest Economy in Utility Power Plant Operation
II—Coal and the Boiler

By Charles Brossmann, Consulting Engineer, Indianapolis, Indiana

(The first in this series of six articles appeared in the January issue.—Editor.)

About the year 1760 James Tilghman, of Philadelphia, discovered coal near his city and sent a piece of the anthracite found to London, stating that some day his mineral would be valuable. Nothing further seems to have been done until 1800, when William Morris took a load of coal from the mine, about 100 miles away, and hauled it to Philadelphia. But he could not sell it, and people thought he was foolish to buy and try to burn rocks, and said that it could not be done. Shortly after this several enterprising persons brought some coal from Mauch Chunk to Philadelphia, advertised it with hand bills, and made practical demonstrations in public, and were successful in selling it and getting orders for more coal. About 100 years later 90 millions of tons of anthracite were produced in Pennsylvania. So much for the brief history of anthracite.

Boilers Built for Hard Coal Used for Soft Coal

The seat of industry, of course, was first in the East. Boilers were made and set, as far as a limited knowledge of combustion allowed, to suit the coal in these districts. As progress extended to the West the same types of boilers and settings continued to be used and are still largely used to this day. But is the coal the same? Anthracite is largely carbon—roughly, 90 to 95 per cent.—and only a small amount of volatile or gaseous matter. Bituminous coal is largely volatile matter (around 40 per cent.), with a much smaller percentage

of carbon than anthracite. But still many insist on trying to burn soft coal in the narrow, cramped boiler setting first adopted for anthracite. Boilers are set close to the grates and filled back of the bridge wall, so that there is little combustion space. There doesn't seem to be any answer as to why so many boilers are still set as of old, unless it is the excuse that it is so easy to copy what the other fellow has done.

Hints on Boiler Setting

Nevertheless, coal of this Central and Western country requires room to burn, lots of it; in fact, it is hard to give it too much space. Pure carbon doesn't require the space for combustion that a coal which is almost one-half volatile matter does, and this you should bear in mind when you erect your next boiler. Also, don't forget that gases distilled from such coal must have something hot to ignite them, whether it be the fire itself or a hot fire brick surface. The temperature must be high enough and there must also be sufficient room to promote or allow such proper combustion. Of course, if you do not have the best kind of setting, you must make the best of your present conditions, making such changes as are possible under these circumstances. If your settings are badly designed, there is all the more reason for careful and intelligent firing and for watching the small things around the boiler plant. Do not think that you are going to slice off a great chunk of operating expense at one point. Do not think or figure too much in round numbers, but get after the fractions. Each little thing in itself must be followed up carefully and you will notice the improvement after you get at all of them.

Items Affecting Your Boiler Room Economy

Here are a few things that you can consider as your fractions that will amount as a whole to something worth while. Perhaps in some plants one or two items will make quite a showing.

Proper Draft: Damper regulation and equalization; excess air; air through grates; and, air through settings.

Proper Coal: Correct handling of coal, and thickness of fires.

Proper Grates: Area of grates for coal; baffles and brick work; efficiency of furnaces, and efficiency of boilers.

Now, whatever you do, try to keep some kind of record of the things that happen around your boiler plant, and certain fundamental truths will soon become apparent.

Watch the Draft

No doubt you have noticed that on certain days the draft on your furnace was much better than other days. Therefore, the fire burned better, brighter and brisker than on cloudy days or days when the atmosphere felt heavy. If you have not noticed this, then ask your fireman—he has no doubt noticed it. Perhaps there is plenty or more than enough draft, even on the bad, cloudy days. Then certainly there is an excess on the good days. But is there any change made in the damper regulation to cut down or increase draft according to atmospheric conditions or load conditions of your boilers?

You would not think of driving your auto winter and summer with the same carburetor adjustment, would you? In fact, you probably could not do it. But you abuse your boiler furnace efficiency simply because you won't or don't know that it should be changed to suit conditions. Only a few weeks ago I was asked to look over a boiler plant and found this very thing. Three boilers and the damper wide open and with a very strong draft, but the fireman and engineer both said they never change it. In 15 minutes we had a temporary arrangement for putting the damper in different positions and had started to cut down on the draft, carrying only enough to get proper results. After talking to the engineer and fireman, they said that they had never looked at it in this way, and promised to try it and said that they thought it was a good idea.

Excess Air Wastes Money

In this case it was important to carry the draft as low as possible, as the settings were full of openings and cracks, which admitted a great amount of excess air. Excess air, of course, will be the cause of inefficiency. We know that you cannot burn coal with just the theoretical amount of air required for proper combustion, but we do know, and it is a matter of record, that we do not need much over 40 to 50 per cent. excess air. Yet we find on analysis of flue gases in many plants excess air several hundred per cent. over what is necessary, and this several hundred per cent. is a direct loss and is actually throwing money away by heating cold air.

Locating Air Leaks

Now, it is not in the province of this article to go into everything in the way of combustion, but one great thing of importance is the excess air problem, and it is not difficult to overcome a good portion of it in many plants. Common-sense, a candle and something to stop up the cracks will work wonders. Don't stop at the visible crack, but hunt around systematically for the hidden openings. If your plant is an old one, you will probably find them. Use the candle at all cracks and see where the flame is sucked in. If it is a new plant, you may find cracks also. It depends on how well the work was inspected as it was built.

Not long ago, in a plant, I pulled out my match box in front of the owner and tried the cracks for air leakage. "Oh, yes," said the owner, "I know all about that. A man was in here and wanted to sell me stuff to cover these cracks." "Well, the sooner you do it the more you will help the coal shortage and your pocketbook," I replied.

Method and Cost of Stopping Air Leaks

You can buy prepared flexible paint that will cover the ordinary cracks over the boiler setting and that has enough elasticity to contract and expand with the setting. The cost of such prepared material will run from 2 to 4 cts. per square foot, dependent on size. One ordinary 150-h.p. boiler will require about $12 worth of material. Is it worth while spending $12 to stop that waste? If you won't do this, make up something that can be caulked into the cracks. Use waste and thin fire clay, and then paint with heavy oil paint over the whole setting for the small cracks. Use asbestos or fire clay or a mixture of the two for the large holes. Go all around the settings; where the shell joins the brick work; where the blow-off pipe and boiler feed pipe enters; go all around doors and iron work and see that doors fit tight, and you will be surprised how many holes you find. Probably this winter some of you put weather strips on your windows at home to save fuel. Why did you do it? Could you feel cold air blowing in around the window casings? This is just what is happening around your boilers, and if you were a little red devil inside the furnace and felt that excess cold air coming in, you would yell for weather strips outside. Only this air to the boiler is sucked in by the vacuum or draft and you can't feel it. So you don't bother, and, if any one speaks of it, you smile. Perhaps, after this winter's coal trouble, you may be inclined to listen. Let us hope. But don't forget the candle and wicking and fire clay or other stuff to fill the cracks. It costs money to heat cold air. If you ran a furnace at home this winter, perhaps you know it. It costs just as much to heat air under a boiler.

You say that your fireman is too busy or your engineer can't take the time. Of course. Dig into your pocket and pay a laborer for a few days to do this. Let him take his time and get it done right. It doesn't require much skill to do this. Just loosen up with a few dollars and see what you can do.

Don't blame the fireman for the cracks or excess air. Any brick boiler setting gets some cracks, and they are easily taken care of.

Other Things to Do

* * * * * * A whole week has passed. Did you get those cracks stopped up? Well, I am glad to hear it, because there are several other things still to be done, and I

hate to spring them all at once, as you have a good many other things to think of, and I know most men are forgetful about the fractions. Don't put these things off, though, and remember that he who is successful not only sees an opportunity, but seizes it.

Damper Regulation

Let's assume that you have fixed up as far as possible all air leaks and have now arranged your stack damper so that it is cut down to where it should be, and don't take for granted that it is all right. Let me relate something that happened on a boiler installation where I had been engaged to have a new boiler placed in an old plant. We placed it next to the old boilers; everything was set up, as we thought, right. And it was. The old boilers had an automatic damper regulator in the breeching, and when the new boiler was started I was away, and was called on the 'phone and advised that they could not carry any load. The engineer pointed to the fire, saying the fire was all right. There was something wrong in the setting. It was too high, for one thing, he said. (The boiler shell was 8 ft. above the floor.) We put on the draft gage and tried it at various points, and found that the damper regulator was connected up backwards—and it evidently had been operated in this manner before we placed the new boiler. How they operated properly I do not know, but after we changed it we ran a test and ran this small new boiler at an average load for several days at 147 per cent. of rating, and at times 200 per cent. of its rated load. This was a small return tubular boiler.

Now, at another plant complaint was made that the coal consumption was too high. This plant had a good, high stack and lots of draft. The damper was found wide open, and simply by cutting down on the draft at the stack damper a saving of from 7,000 to 8,000 lbs. of coal per 24 hours was made. So that these two examples prove that there is something in damper or draft regulation.

Fire One Side of Furnace at a Time

No doubt you have provided means for fixing the damper at any desired point, and have placed it so it will pull the load and still be shut as far as possible. You have also stopped the air leaks and this has further improved your draft, and no doubt you have noticed it. But what about your fires? If they are hand-fired, probably some improvement might be made.

Here is an instance. One man had three boilers and six fire doors. He starts at the left—fills at each door as high as he can, progressing toward the right. To make matters worse, two of his boilers are in one setting—four fire doors with no wall between the two boilers. Think of that grate being piled up with green coal! Just like starting a new fire every time he shoveled it. I finally had him number his fire doors and then to fire lightly at doors 1, 3 and 5, and then, after an interval, to fire lightly at doors 2, 4 and 6. I explained how one side would be hot at all times, and there would be more chance to burn the gases distilled from the green coal. The hot fire on one side would help that. He would only be cooling off one side at a time.

And it makes a difference. Try it. Shovel first on one side, then alternate to the next boiler. If you only have one boiler, fire first one side and wait before firing the other side, so that one side of the fire is always hot. Keep the holes or black spots covered. Four to six scoops of coal at a time is plenty for one side. Fire lightly and often and keep your dead plate clean. Fire before you burn too low, so as to prevent holes and an inrush of cold air, and try to cover the fire when near white heat. Don't forget that a furnace is intended to be hot. That is what it is made for. Get the heat into your boiler and not out the stack. Get a thermometer and try your stack temperature to see that it is not excessive. Your firing will have to be done to suit your judgment, as different boilers require different methods, and no one can expect to be told all the little things that help take care of your particular plant. Every plant has its own little peculiarities, but remember that in every plant economy must be based on a certain foundation.

Things to Remember

Remember several important things:

Excess air—do away with it. Draft or damper regulation—watch it; not once a day, but several times a day, as the need or occasion may arise. Proper firing—*Fire light and often.* Place a sign in front of your boilers, so it won't be forgotten. Here are three things for you to study and watch, and they are three things that cause much of the loss in coal that is preventable.

Before you forget, let me suggest that you use as a little sign the accompanying suggestions for firemen. Frame it, with glass over it, so that it can be kept clean. Hang it in your boiler room, on the boiler or where your fireman can always see it, and then see that he follows it as closely as circumstances will permit.

SUGGESTIONS FOR FIREMAN

Break all Lumps of Coal so they are not Larger than your Fist.

Fire One Side of Furnace at a time, so that the Hot Side will Burn the New Gases.

Spread the Coal as it Leaves the Shovel. Don't land it All in a Heap.

Fire Little. Fire Often. Use only a Few Scoops at a time.

Don't allow Holes to form in Fire. Keep Fire Even and Level.

Don't allow your Fire to Burn Down Dull before Firing.

Keep your Ash Pit Bright. Don't allow Ashes to Collect.

Watch your Draft. Don't carry an Excess of Draft, and Regulate Damper at Stack to Suit Conditions.

Keep a Record of what you are Doing. Coal Burned Daily, etc.

Ask to have Scales to Weigh Coal, and a Draft Gage to Watch Draft.

Turn in some kind of a Report, so that when you Improve Conditions it will be Noticed.

Use your Head as well as your Arms.

Acting on Recommendations of U. S. Public Health Service in Improving Quality of Meridian, Miss., Water Supply

By M. L. Worrell, Manager Water Department, City of Meridian, Mississippi

In order to make this article of more value to the particular reader, so that a ready grasp of the situation may be his, it may not be amiss to describe the surroundings.

Population, Climate and Topography

Meridian, the largest city in the state of Mississippi, and the county seat of Lauderdale County, is located in the east-central section of the state, near the Alabama line. The estimated population of the city for 1917 was 32,000, of which 62 percent is white and 38 percent negro. The city is a railroad center and has a large variety of manufacturing plants, besides being the center of an extensive agricultural region. It lies in the physiographic division known as the Gulf Coast Plain, and the elevation of the city is 352 ft.

above sea level. The climate is typical of cities of like latitude, and removed from close proximity to large bodies of water. The summers are moderately hot, and frost is frequent in winter, especially the present. The average temperature for the year is 64 degrees, the mean temperature being 80 and 45 for July and January, respectively. The surrounding country is characterized by broken series of ridges and hills and ramified by an intricate system of streams and valleys; this extensive system of streams running, for the most part, in a southerly direction, affording an efficient regional drainage.

Management

A number of railroads pass through Meridian and take water for interstate carriers, local freight stations and very extensive shops, stock pens, etc., all of the railroads having contracts with the City of Meridian, which owns the water works system. The city has the commission form of government and the administration of the water department is under the jurisdiction of the superintendent of water works and public property, though a manager is employed, who has direct charge of the engineering and supervision of the water system. The U. S. Public Health Service sanitary engineer who inspected the filtration plant and catchment area said of this official: "He is an expert in his line of business, has had long experience and is fully alive to the necessity of having an unimpeachable water supply."

Catchment Area

The catchment area which supplies the water used by the City of Meridian consists of an area of about 2,200 acres, located about three miles to the southeast of the city. Of this area the city has owned for many years about 750 acres, and is now acquiring the entire ownership acting under the advice of the U. S. Public Health Service. About 80 percent of the land is wooded with pine, with a small variety of other growths, and the remaining 20 percent is partly cultivated—rather has been until recently—and partly cut-over land formerly used for grazing purposes. The soil consists, for the most part, of coarse red sand, which is poorly adapted for agricultural purposes.

Sources of Supply and Contamination

The water supply comes from three streams, fed by a number of springs, which flow in a general direction west, toward the reservoirs. At present two country roads traverse the catchment area, one bisecting the other at a point distant from the reservoir about one-third of a mile, and there is considerable traveling of country wagons, lumber wagons and conveyances of various kinds. There have been 15 or 20 houses, occupied by negroes exclusively, located on this watershed, among them being a church and lodge, where a large number of "cullud breddren and sistern" occasionally congregate. The presence of these houses, church, lodge and public roads have always proven a source of contamination of the water supply of Meridian, and while there has never been an epidemic of typhoid or other water borne disease, typhoid is always with us, the curve going up as summer begins and down as autumn wanes into winter. Investigations of the presence of typhoid in the city, with the idea of determining the possible course of infection, have not resulted in definitely fixing the responsibility further than that the most of the cases were of the "imported" order, the spread to nearby houses being attributed to flies. The typhoid bacillus has never been shown, to a certainty, in the water works water and that this has never been the real source of infection is pretty well proven by the fact of there never having been an epidemic of that disease in Meridian. That conditions on the watershed might easily lead to such an epidemic may readily be seen and for the purpose of remedying these conditions, not only in Meridian but throughout the country, the order of the U. S. Public Health Service dated Feb. 12, 1917, calling for a field survey of catchment areas and filtration plants, was promulgated. That an inspection of these conditions, with the proper remedy applied for relief, can result in much greater security for the health of any community will not be denied.

Recommendations of U. S. Public Health Service

Meridian's catchment area and filtration plant were inspected by the Public Health Service of the United States and her water supply, so far as interstate carriers use was concerned, was promptly condemned by order of the Surgeon General until we carried out, at least in part, certain recommendations which are here given:

1. The abandonment of all habitations along the water sheds of the streams furnishing water supply of the City of Meridian.

2. Closure to traffic of the roadways leading through water shed.

3. Installation of necessary apparatus which will allow for the treatment of the water supply with liquid chlorine, this being considered about the most satisfactory and easiest method of treating it.

4. A routine bacteriological examination of the unfiltered and filtered water to determine the efficiency of the filters.

With no desire to claim undue credit, each and every recommendation above listed had already been made to the present and prior administrations by the author of this paper.

Acting on Recommendations

Coming from the source of highest authority, backed by a "big stick," prompt action was had, the result being that the county authorities promptly passed an order to close the roadways within a certain time, the city began the purchase of every house site first and the wooded and cultivated lands second; the immediate installation of a liquid chlorine plant, a bond issue to pay for the extensive purchases of lands, and improvements and additions to the filter plant, the routine examination of the water to be made by the writer of this article and checked by the bacteriologist of the State Board of Health, whose methods have been approved by the U. S. Public Health Service, with frequent periodical examinations of the water by the State Board and occasional examinations by the U. S. Public Health Service through the office and laboratory of the Interstate Sanitary Officer. When the chlorine apparatus was installed—this being done forthwith after the condemnation—and treatment begun, the water was again examined by the Interstate Sanitary Officer and pronounced practically sterile, whereupon the embargo on Meridian's water supply by the Public Health Service was promptly lifted. Each examination made since has shown the same result.

The closure of the public roads has not yet become effective, due to legal delays which will soon be removed. We have not yet purchased all of the lands of the catchment area, though options have been secured and condemnation proceedings instituted against all those with whom we were unable to settle, on not a fair but an exorbitant basis, as the City of Meridian, like many other cities undergoing the same trouble, has been "held up" by the owners on account of the necessities of the case. These lands, at best worth but a few dollars per acre for agricultural and grazing purposes, have been held at from $10 to $150 per acre. We have not been able to purchase any at less than $10, though we have not paid exceeding $20 per acre, these prices not including any improvements, preferring to resort to the courts under the rights of eminent domain rather than to be robbed!"

Storage and Purification

Meridian outgrew the output of the springs several years ago and had to resort to larger storage reservoirs several

times until we now have a storage capacity of half a billion gallons and covering about one hundred acres, these reservoirs being located at the lower end of the catchment area. Natural sedimentation takes place within these reservoirs as they are, combined, about one mile in length and of varying depth, 2 to 30 ft. The water flows by gravity to the pumping station and filtration plant, located within the city limits and distant 8,000 ft., where it is treated with filter alum and hydrated lime in the usual manner, passed through a typical settling basin and on to the filters, still by gravity, and into a clear-water basin, from which it is taken by pump suction and pumped direct to the consumers. The water is low in alkalinity, naturally, and unless an artificial alkali is used it loses all of its alkalinity and an acid water results, the troubles of which are well known under the head and title of "Red Water Troubles."

Salamanca Finds Gas Engines Dependable

The city of Salamanca, N. Y., recently contracted for another gas engine to meet the city's increasing power and light requirements. It is a 350-h.p. 4-cylinder Bruce-Macbeth unit, direct connected to alternating current generator.

This is the seventh Bruce-Macbeth engine to be installed by the city of Salamanca, the first one being installed over ten years ago. For some time a steam plant was kept in operation as well as the gas plant, but a number of years ago the steam plant was displaced altogether and all water and light service furnished by gas.

The unit now being installed is arranged so that it can be operated either with gas or coal, in conjunction with which a gas producer has also been contracted for, which will automatically produce gas from coal.

SEWER DESIGN AND CONSTRUCTION

Present Tendencies in Sewer Construction and Design

By H. K. Barrows, M. Am. Soc. C. E., Consulting Engineer, 6 Beacon St., Boston

The past year has seen the formal entry of our country into the great war. We are facing unprecedented conditions and requiring billions of dollars for war purposes and supplies. This has already resulted in the national control of the great essentials—food, fuel and transportation—and we are face to face with conditions which prohibit any construction which is not urgent.

The cost of materials for sewer construction was already at an approximate maximum early in 1917 and the year has seen in general no considerable further increase in cost, but rather more difficulty in obtaining materials promptly owing to freight embargoes and delays. Labor costs have steadily increased, however, owing chiefly to war demands, both direct and indirect, and conditions have become such that little or no contract work on projects requiring a year or more to complete can be safely undertaken except upon a percentage (or cost plus fixed sum) basis.

Effect of Present Conditions

The effect of the present conditions upon sewer construction and planning is seen in several ways, viz.:

The work during 1917 was confined almost wholly to necessary extensions and few new sewerage systems were begun. In New England, as far as the writer is informed, there were but two new systems started, viz., at Reading Mass., and West Haven, Conn.

Marked Tendency to Use Labor-Saving Machinery

There has been a marked tendency to utilize to a greater extent in construction labor-saving devices, including trench excavators and backfillers, etc., and the continuance of abnormal labor costs will serve greatly to stimulate the development and use of such appliances.

The abeyance in construction has made it possible in some cases, however, to give more time and needed attention to the design of new works or extensions. While war demands have already been heavy on the engineer and there is a dearth particularly of men of the age who would normally be most active in construction, the number of older men and the

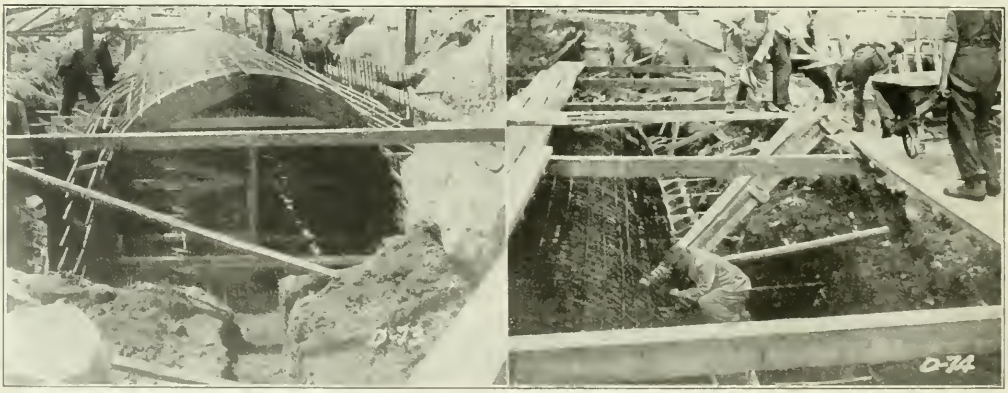


FIG. 1—CONSTRUCTION VIEWS OF 10-FT. COVERED SECTION OF FALL RIVER (MASS.) INTERCEPTING DRAIN. Left: Forms Ready for Pouring Invert and Walls. Outside Arch Forms and Reinforcement Placed After Invert and Wall Have Set. Right: Pouring Invert Through Opening Made by Omitting Boards in Arch Form.

city and town engineers have not been as yet greatly depicted, and there is now the opportunity—badly needed in some cases—to give more attention to adequate planning and design of sewerage systems.

Trend Toward Separate System

The trend is in general strongly toward the use of separate systems of sewerage, but in many cases storm water sewers have not been given adequate study and attention, and consequently much waste has ensued and reconstruction has been required—not to mention losses from flooding cellars and buildings.

War times have brought an increased appreciation of the possible value of the by-products of sewage—grease, ammonia, etc.—and stimulated study and experiment upon processes of sewage treatment. The most notable recent contribution along this line is the "Miles Process" of sewage treatment, for which preliminary experiments have indicated great possibilities and even a profit from the sewage by-products. Obviously the success of any such process would require the use of a separate system of sewerage and the possibilities in this direction provide, in fact, a strong general argument in favor of the separate system.

Materials Used

For the smaller sizes of sewers (and up to from 24 to 30 ins. in diameter) vitrified sewer pipe is most generally used.

In some cases 30 and 36-in. vitrified pipe have been used (particularly on government contracts during the past year). As a rule, however, although convenient and quick to lay, these larger sizes of vitrified pipe are more expensive than concrete or other built-up sections. They also require great care in backfilling to avoid unequal settlement and possible fracture of the pipe due to its rigidity. Where the trench is soft the larger pipe are particularly liable to fracture and sizes over 24-in. may be undesirable.

Lock joint (concrete) pipe in sizes from 24-in. upwards also overlaps the upper portion of the field held by the vitrified pipe.

Pipe Joints

In sanitary sewers it is very important to obtain tight pipe joints, as otherwise large quantities of ground water will have to be carried and perhaps subjected to treatment, at increased cost with no resulting advantage. Furthermore, trouble is more likely to occur from roots entering the joints and clogging the pipe, if the joints are not tight.

An excellent and comprehensive discussion of sewer pipe joints was evolved at the January meeting of the Sanitary Section of the Boston Society of Civil Engineers. (See Journal of the Society for February, 1918.) Many practical results of experience were given showing progress in this important detail.

In the majority of cases discussed cement mortar joints are in use, with a growing tendency to use a poured joint—viz., of "G-K" compound (or, in a few cases, of sulphur and sand), especially in wet trenches, where the bottom of a cement joint is likely to be defective. Careful inspection is another important requisite to insure perfect joints.

Large Sewers

For larger sewers—30-in. and above—considerable latitude segmental block and brick are all in use—depending somewhat upon local conditions and, particularly during the past year, upon the availability of materials within a reasonable time.

In these days of uncertain freight deliveries, concrete has the advantage of a minimum percentage of material requiring shipment. If cement can be obtained the remaining 85% or so of sand and gravel or broken stone is usually available locally. On the other hand, the labor cost of concrete, including mixing and placing, constructing, placing and removing forms, etc., is now much above the normal and may more than offset the advantage in cost and availability of materials.

In Table I are given data of cost of concrete, from careful cost accounts, for a large reinforced concrete storm water drain built at Fall River during 1915 under the direction of the writer, under what may be called approximately normal or pre-war costs. A construction view of one of the sections of this drain, 10 ft. × 6 ft. 9 ins., is appended. See Fig. 1. For comparison are given the approximate costs based upon present prices, as well as can be estimated.

Table I—Cost of Concrete per Cubic Yard—Fall River Intercepting Drain

(Not including reinforcement.)

	—1915—		—1918—	
Item	Actual Cost per cu. yd. of Concrete	Per cent. of Total Cost	Est. Cost per cu. yd. of Concrete	Per cent. of Total Cost
Labor—				
Forms—making, placing, etc.	$2.03			
Concrete — mixing, placing and finishing	1.55			
Teaming — cement, forms, etc.	.46			
Insurance	.20			
	$4.24	45	$7.10	49
Materials—				
Lumber (forms, etc.)	.25			
Sand and stone	2.05			
Cement	2.00			
	$4.30	45	6.27	43
Equipment—				
Plant, tools, power, etc.	.93	10	1.24	8
Total cost	$9.47	100	$14.61	100

From Table I it will be noted that this work under present conditions would cost about 55% more than in 1915. Labor costs have increased somewhat more in proportion than materials, but not greatly so.

In the long run, advances in cost of labor and materials tend toward the same general percentage increase, although temporary—particularly local—differences favoring one or the other are likely to occur from time to time.

Tendencies in Construction

For more general information regarding present tendencies in sewer construction the writer addressed a circular letter to officials of ten representative cities and towns in New England late in 1917, and received replies from six, with the following general results:

The maximum size of vitrified pipe alone as used varies from 15 to 30 ins., although more commonly from 24 to 30 ins. Above 15 ins. there is some tendency to supplement the strength of the pipe where foundations are poor by using concrete.

During the past year construction work of sewer extensions on the whole has not decreased materially in amount, particularly with pipe sewers. Of six cities and towns three showed either about the normal amount of work, or some increase, and three a decrease in amount.

Costs have, of course, been invariably greater than normal. Materials varied from a 10% to 100% increase and labor from a 15% to 100% increase, according to the opinions expressed.

For the larger sewers concrete—plain and reinforced, segmental blocks, lock-joint pipe and brick have all been used, the amounts laid being about in the order given.

Of the six cities and towns, four have used some kind of trench machine, varying from the ordinary clam shell bucket

and derrick to various types of excavators and backfillers.

The work done at Hartford, Conn., in the last two or three years well represents construction tendencies, and through the courtesy of Mr. Roscoe N. Clark, M. Am. Soc. C. E., City Engineer, the writer is able to present herewith construction views and notes regarding work upon sewers. This is all contract work, and for sizes which have varied from 30 to 60

VIEWS ILLUSTRATING USE OF LABOR-SAVING MACHINERY ON SEWER CONSTRUCTION.

Fig. 2—Thew Steam Shovel Operating in Conjunction with Gasoline-Driven Air Compressor for Rock Drills in Sewer Excavation. Cut 7 to 20-ft. Fig. 3—Fogarty Excavator Digging Sewer Trench from 13 to 16-ft. Deep. Fig. 4—Austin Trench Machine on Sewer Cut Ranging from 8 to 11-ft.

ins. bids have been received upon plain concrete, segmental block and lock-joint pipe, with the result that in the majority of cases the segmental block has been used.

Fig. 2 shows a section of segmental block sewer (30 ins. to 60 ins. in diameter and about a mile long), built through farm land recently cut into building lots. After construction the sewer was backfilled by hand to a depth of about 2 ft. and the remaining fill done with a Thew shovel. Depth of cut, 7 to 20 ft.—plenty of room and no pipes encountered.

Fig. 3 illustrates the use of a Fogarty excavator, with lock-joint pipe, with spoil handled by teams and sheeted trench—13 to 16 ft. deep.

An Austin trench machine (Fig. 4) was also used on some 2½ miles of segmental block sewer and 8 to 11 ft. cut, with good progress, particularly where no sheeting was required. On this same work an Austin backfiller was also used.

Various other trench machines have been used at Hartford, including the Carson, Parsons and Moore.

The use of trench machines for economy in construction is now a matter for careful consideration where any considerable amount of sewer construction is contemplated. The immediate or operating cost of handling material is greatly lessened where conditions are at all suitable for the use of such a machine. Furthermore, there are several good types on the market which are already well developed and which in the light of practical use are being steadily improved. In estimating the cost of using such a machine a liberal allowance to cover fixed charges and repairs should, of course, be made. A depreciation of 25 to 33% per year is advisable to use in making such estimates, and as with all other large items of construction plant cost, such a machine must be kept at work in order to pay for itself.

For the coming year, where large sewers are to be constructed, local conditions as affecting the cost and possibility of obtaining different kinds of materials as well as labor, must be given much more than the ordinary amount of consideration by the contractor and engineer.

Procedure in Construction of Lock Joint Sewer Tile

The production of lock joint sewer tile was the manufacturer's solution of the problem stated by the engineer, who called for a sewer material with all the good qualities of vitrified, salt-glazed, sanitary sewer pipe, yet suitable for use in sewers of large diameter. Until this tile was produced engineers specified either brick or concrete for large sewers. The tile is now so well established as a dependable material of construction that it is included in the specifications of nearly all the large cities throughout the country.

Lock joint sewer tile has been developed to its present design under service conditions. First, the single ring segment block was put on the market and it met with the approval of engineers. Next, came the double ring or two-piece block, which was made for sewers from 30 to 144 ins. in diameter. The two-piece block is more to the engineers' liking as it makes a water-tight sewer. This is due to the double wall construction as there is ¼-in. bed of cement mortar between the inner and the outer block and the blocks overlap one another for a distance of about 9 ins. This construction makes it almost impossible for water to seep through at the joints.

Laying the Tile

When laying segment blocks in a dry ditch the contractor shapes his ditch to the outside diameter of the sewer. He sets up a wood templet about 20 ft. from the start of the work and stretches lines to correspond to the width of the outside blocks and then starts the outside course with half blocks (or 9-in. lengths), thus causing an overlap of 9 ins. between the inner and outer block. He lays the outside block up to the spring line and then goes back and covers the inner surface of the outer block with mortar and then lays the inside block.

To turn the crown of sewer, the contractor uses a wooden form of curvature to correspond to the inside diameter of the sewer. The form is from 5 to 15 ft. in length, as the contractor desires, for some contractors prefer a long form to save time.

In a wet ditch a patent steel templet is used to lay the outside course of block. This holds the blocks to the true diameter of the sewer and gives the contractor a chance to backfill behind the blocks.

On segment block work the ditch can be backfilled as soon as blocks are laid. Some contractors use the revolving steam shovel and backfill as they progress with the sewer.

Specific Examples

A 36-in. segment block sewer was put in at Elmhurst, Ill., last fall and the contractor was able to lay 165 ft. of completed sewer in one day with a gang of 8 men. On a 60-in. sewer at South Bend, Ind., the contractor put in 100 ft. of finished sewer with a gang of ten men, thus bringing the cost of laying the block below 1 cent per inch of diameter per lineal foot of sewer. A segment block sewer was put in at Davenport, Ia., this winter on which the contractor worked nearly the entire winter. He averaged more than 50 ft. a day on 54 and 48-in. diameter sewer in the coldest winter in recent years.

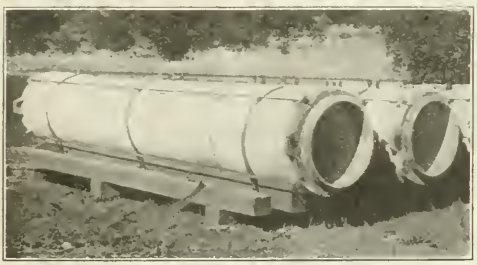
Construction of the Precast Reinforced Concrete Submerged Sewer Outfall at Lakewood, Ohio

There was recently put in service a reinforced concrete pipe outfall sewer at Lakewood, Ohio, that is laid under the water of Lake Erie. This line is laid just east of where Rocky river empties into the lake, and carries the treated sewage from the Imhoff tanks recently completed to take care of the sewage of the city of Lakewood. This line is the first built of its kind.

The outfall from where it connects with the land section to the outer end is 1,500 ft. long, consisting of 1,100 ft. of 36-in. pipe and about 200 ft. each of 30-in. and 24-in. pipe, with 4-in. holes about 9 ft. on centers, through which the sewage is diffused. In case the flow becomes too great to pass out through these holes, there is provided a flap valve with weights on the end pipe.

The Pipe

The pipe for this line was manufactured at a plant established near the freight yard of the Nickle Plate railroad at Rocky river. It was made in short sections and hauled to the water's edge and assembled into 22-ft. 2-in. lengths; each section consists of three pieces of pipe 4 ft. long and two pieces 5 ft. 1 in. long. The latter have special cast iron flanges molded in, one to form the bell end of the completed long section and the other the spigot end. The spigot end casting has a groove, in which a lead pipe is placed to act as a gasket. Some of the completed long sections are here illustrated.



BUILT-UP SECTIONS OF 36-IN. PRECAST REINFORCED CONCRETE PIPE FOR SUBMERGED SEWER OUTFALL AT LAKEWOOD, OHIO.

The short lengths were assembled on timber cradles, as shown, and after being bolted together the joints between the short sections were made. The long sections were then ready to be laid. The 30-in. and 24-in. pipe were built up in the same way as the 36-in.

The reinforcement used was triangle mesh of the American Steel and Wire Company. The concrete was 1 part cement, 1½ parts sand and 2½ parts stone. The pipe was designed to stand an internal pressure of 20 lbs. to the square inch.

Placing the Sections

The 22-ft. 2-in. sections were taken out to the place where they were to be laid on derrick scows, lowered into place, and a diver connected them together on the bottom of the lake. About five sections, or a little over 110 ft., was the average length laid per day.

This work was under the direct charge of Mr. E. A. Fisher, city engineer, and Mr. R. Winthrop Pratt, consulting engineer. The pipe was manufactured by the Lock Joint Pipe Company, of Ampere, N. J., and was laid by the American Construction Company, of Cleveland, Ohio.

Design and Cleaning of Sewer Catch Basins

By George A. Carpenter, City Engineer, Providence, R. I.

Different cities have adopted different forms of catch-basins and inlets and some engineers even recommend taking storm-water directly into the sewer without any intervening basin in which street detritus may be collected. These argue that, with sufficient velocity in the sewers to carry such street dirt along, it is easier and cheaper to collect it in a few grit chambers located in the line of the sewer and remove it from there than to collect and remove it from a large number of catch-basins. In this section, however, the general practice is to build catch-basins, and these have been designed upon various plans, said Mr. Carpenter in addressing the Providence Engineering Society.

The Providence Basin

The city has one of the best types of catch-basin. Starting originally with the circular brick basin covered with a granite gutter stone and a granite head stone forming part of the street curb it later developed the cast-iron D Frame and cover for the same basin, and now uses this form exclusively. Cutting an opening through the granite curbing for an entrance for the storm-water, the walls of the basin are drawn in at the top, and it is then capped with a cast-iron frame and cover. Nothing is visible above the surface of the sidewalk except the cover and no break is made in the street curb, or in the paving of the gutter. This design affords one of the neatest and most effective basins for city streets that the author has seen. Recognizing a good thing when it saw it, the City of Pawtucket has used this type of basin for many years.

Experiments with Basins

The author has made occasional experiments with basins constructed to meet special conditions and also with basins built to render cleaning less expensive. One of these was the construction of a basin with an interior wall of soft, porous brick and a drainage space between inner and outer wall. This space between the walls was connected by a 4-in. pipe with the main pipe running from the basin to the sewer and was designed to drain the basin and produce dryer material for removal when cleaning.

The basin was trapped by a running S-trap on the main connection, just outside the basin wall, and this was protected from sticks and other obstruction by a cast-iron hood hung on the inside wall of the basin. The S-trap provided a water seal after the water in the basin itself had escaped through the porous wall.

Only a few of these basins were built, as an experiment, for it was anticipated that the porous bricks might stop up in time and cease to operate as designed. The basins continued to work as planned, however, and required no bailing of water in advance of cleaning and the material was easier to excavate. After being in service for a dozen years or more the man who inspects the condition of catch-basins reports that they are

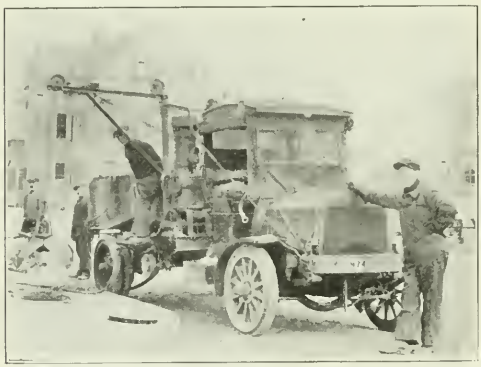
still operating as intended and that the walls of porous bricks have not become clogged.

The following credits may be given to this type of basin: There is no water to be bailed out before cleaning. The material in the basin is in a better condition to handle and cart away by the old hand method of cleaning. The basin is trapped by a small quantity of water and the water-seal is more permanent than with the hood-trap. This basin does not breed mosquitoes. If this basin is neglected and becomes filled with dirt above the hood, there is still an outlet under the hood where the water will drain off and leave the street clear.

Modern Methods of Basin Cleaning

With the modern methods of cleaning basins, however, the desirability of dry material becomes of less importance.

During the author's experience he has often had visions of reducing the cost of cleaning by the old hand method and has spent hours trying to work out some form of basin construction which would contribute to this end. His schemes have varied all the way from buckets, or tubs, in the basin, which could be hoisted to the surface when full and dumped directly into a car, to a small ladder dredge working through the cover or through a specially designed opening. All these schemes have ultimately led to the conclusion that any cleaning device, to be practicable, must be adaptable to the present form of basin, as there are too many basins in use to think of general reconstruction.



STANDARD MOTOR TRUCK EQUIPPED FOR CLEANING SEWER CATCH BASINS, PAWTUCKET, R. I.

Pawtucket Cleaning Truck

The Board of Public Works of Pawtucket has recently produced a type of cleaning truck that accomplished the object sought. In its present state it is the result of practical experience on the job, and considerable improvement has been made over the original design. Starting with a simple, self-dumping auto truck equipped with a power-operated hoist, there have been added a water pump and an orange-peel bucket at first hydraulically controlled but recently equipped with compressed air control so that the city now has a machine for the practical and rapid cleaning of basins at a greatly reduced cost.

The truck here illustrated consists of a Standard chassis with a 32 h. p. engine. On this is mounted a steel body made by the Monahon Vehicle Company of Providence, R. I., which measures about 9 ft. by 4½ ft. by 2 1/3 ft. high and has a capacity of 3.4 cu. yds. Cover plates 2 ft. wide are placed over each end to prevent the slopping of the load. The average load has measured about 2.6 cu. yds. and weighed about 3.4 tons.

The tailboard is hinged at the top, provided with a rubber gasket, and can be clamped tightly against the body. The body is provided with a hydraulic lift operated from the transmission system. A pair of 6-in. I-beams are mounted on the chassis back of the driver's seat, and on these I-beams are mounted a 6 h.p. Fairbanks & Morse gasoline engine, a cable-drum and control mechanism and an air compressor. The cable runs to an outrigger which can be swung out over the catch-basin and back over the cart after the bucket is raised and ready to dump.

The Cleaning Bucket

The first bucket provided for this truck was a plain, cylindrical one 14 ins. in diameter and 17 ins. deep with a capacity of 1½ cu. ft. It was filled by hand by a man in the basin, after the manner of the regular cleaning methods then in use. After operating this equipment from July until November, 1913, an orange-peel bucket controlled and operated by oil under a pressure of about 100 lbs. per square inch was substituted.

Experiments were made later with a bucket operated by compressed air and the improvement in operation was so great that an air compressor has been added to the equipment and the bucket is now operated in that way. These various improvements and attachments have overloaded the truck and it would be advisable to start with a five-ton truck if a new machine were to be built.

When this machine was first put in operation, with a bucket loaded by hand, its average output was 5 loads, or 13 cu. yds., per day of nine hours. With the orange-peel bucket this output was increased to an average of 7 loads, or 18.2 cu. yds., and with the addition of compressed air the average output is about one load per hour, or 23.4 cu. yds. per day.

The length of haul is, of course, a controlling factor in the work of the truck and the condition of the basin is also important. At the present time the truck is cleaning basins which are practically solid full of dry material and on this work it is averaging one load per hour with hauls somewhat in excess of one mile. With basins in an average condition the author believes the daily output can be materially increased. With the bucket averaging three fillings per minute the truck can be filled in about 20 minutes and at 7 miles per hour a trip to a dump one mile away and back can be made in 17 minutes. This should leave ample leeway to make a load, on the average of once in 45 minutes, or 12 loads per day of nine hours.

Hauls to a dump are very likely to become longer and undoubtedly will average considerably more than one mile. With a one mile haul it should be noted that it takes as long to go to the dump and return as it does to fill the truck. This indicates that there may be an opportunity for further economy in having one machine for taking the material from the basin and a separate truck for carting it to the dump.

A Money-Saving Twin-Service Carburetor

Contractors who have been paying high prices for gasoline for engines will welcome a reliable carburetor which will cut the cost of fuel from 24c to 8c per gallon.

This can be accomplished, it is claimed, with the Northwestern Twin-Service carburetor. It is guaranteed by the makers to give the operator dual control of his fuel. He may use either kerosene or gasoline. By means of a superheating attachment, introducing gas from the muffler of the engine, the kerosene is volatilized to the proper point for producing the maximum explosive power within the cylinder. There are two lead pipes from the storage tank equipped with shut-off valves, enabling the operator to draw either fuel as desired.

As Northwestern engines are operated with gravity feed from the fuel tank, there are no difficulties to be overcome with the many small working parts of the pump. This enables users of these carburetors not only to buy engines at favorable prices, but also to save two-thirds of the daily cost of their fuel bills.

Water Purification and Sewage Treatment

Specific Suggestions on the Design of Imhoff Sewage Settling Tanks

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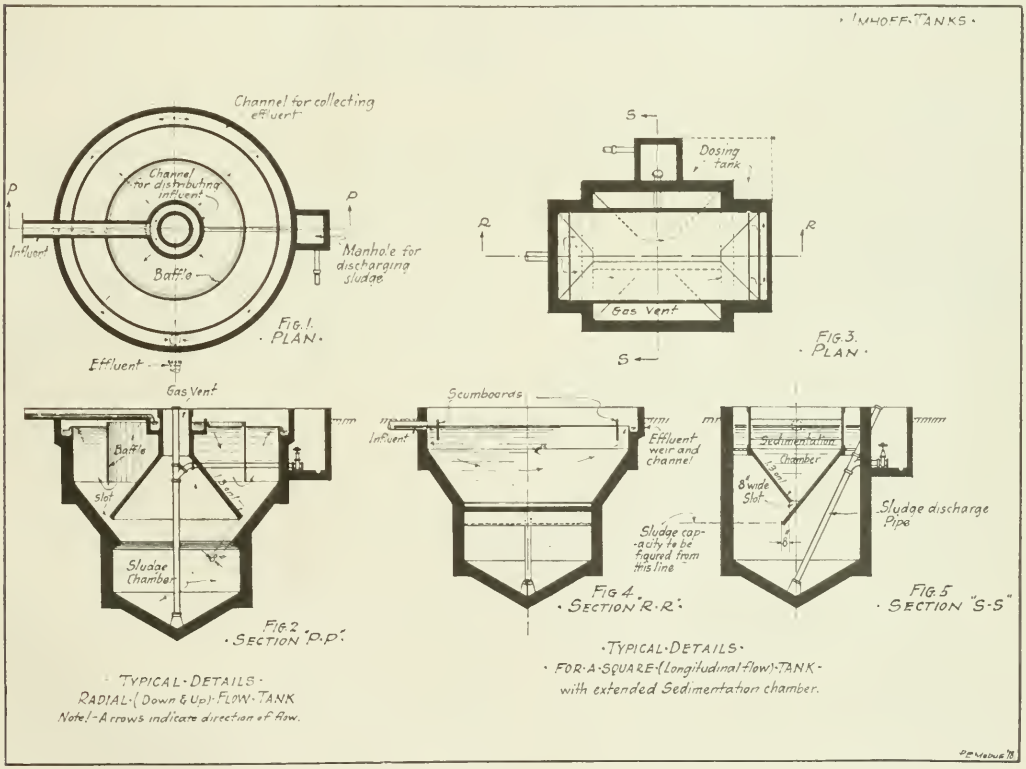
The design of an Imhoff tank is exceedingly important, as the successful operation of the tank depends largely on the design. An improperly designed tank, even if placed in charge of skilled operators, cannot be made to produce satisfactory results. The principles of design are generally simple and readily understood. However, each installation should be carefully studied in itself and when necessary, or when deemed advisable by the designing engineer, the general rules laid down should be modified so as to secure satisfactory operation.



TYPICAL DETAILS OF RADIAL AND LONGITUDINAL FLOW IMHOFF SEWAGE SETTLING TANKS.

Radial Flow Tanks

Imhoff tanks have been designed in two general classes, one having a radial (down and up) flow and the other having a longitudinal flow. These two types are shown in the accompanying sketches, Figs. 1, 2, 3, 4 and 5, respectively. The first type generally has been made circular and the second circular, square or rectangular, the same principles applying for each case.

The radial flow type has the objectionable deep baffle hanging almost over the slots. This causes relatively high velocities near the slot when there should be a "slow motion" zone to permit easy and free passage of the settling solids to the sludge chamber beneath. This type of tank although now largely superceded by the longitudinal flow type, is still used occasionally, but is now modified by removing the deep baffle and placing scumboards only in front of the weirs, as in the longitudinal flow tanks. This shaped tank, minus the deep baffle shown, is used also as a so-called "circumferential" flow tank. A longitudinal partition is placed in the tank together with suitable baffles, so that the influent is divided into two portions, each of which must flow horizontally in a circumferential path to the outlet located directly opposite the inlet.

Longitudinal Flow Tanks

The longitudinal flow type of tank has largely superceded the radial flow type and is now considered generally better for the larger installations. The longitudinal flow type, if only one sludge chamber is used, may be made square or circular, and for United States conditions the sedimentation

chamber is sometimes made to overhang the sludge chamber in order to meet the requirements for sedimentation of the dilute sewages. In the larger tanks, the sedimentation chamber extends over 2, 3, 4 and sometimes even 5 sludge chambers adjoining one another in a single row, although 4 and 5 sludge chambers are now looked on rather with disfavor, because the sludge does not deposit equally in all of them. In still larger installations a multiple settling chamber extends over 2 or 3 single sludge chambers. In such installations the settling chambers must then be designed to be communicating in order to maintain the water level and thereby prevent the passage of sewage from one chamber to another via the sludge chamber, i. e. through the slots. When more than one sludge chamber is used, provision must be made for reversal of flow so that the deposition of the sludge in the chambers will be equalized. In the March issue of Municipal Engineering, pp. 112-114, there was published an article by Mr. W. L. Stevenson, Assistant Engineer in Charge of the Sewage Disposal Division Bureau of Surveys, Philadelphia, Pa., describing the new Philadelphia tanks and the points spoken of above were clearly illustrated in the large drawing, of the Philadelphia tanks, reproduced on page 113.

Design of Settling Chamber

The primary object to be obtained in this chamber is efficient sedimentation, and in order to accomplish this the velocity of flow must be retarded sufficiently to enable the solids to settle out and pass freely into the sludge chamber below. Good U. S. practice now calls for a 2½ to 3-hour retention period, based upon the daily average flow.

The chamber of rectangular tanks may be made either long and narrow, or short and wide, the first resulting in higher velocities and somewhat less efficient sedimentation and the second in low velocities but with greater possibilities of short circuiting of the flow, due to difficulties of securing even distribution over the greater widths. A medium must therefore be struck, which will overcome these two disadvantages.

The length of the chamber hardly ever exceeds 100 ft. and from 80 to 90 ft. is considered a good length. This then will give an average velocity of say 0.6 ft. per minute or about .01 ft. per second, which is well below the absolute maximum velocity for efficient sedimentation (usually considered as 0.1 ft. per sec.) Such low velocities will provide a factor of safety for the usual storm flows. The width of the chamber depends upon the width of the tank, which is generally determined by structural limitations, etc. As the product of the three dimensions must equal the 3-hour flow, it is necessary to adjust the width and depth. If a chamber is too shallow, higher velocities will develop in the "slow motion" zone near the slot, and if made too deep, the full cross-section will not be efficiently utilized. In 9 of the largest representative U. S. installations the depth from the flow line to the slots varies from 10 ft. 10 ins. to 13 ft. 6 ins., the former being at Rochester and the latter in the new Philadelphia tanks just designed. This latter seems to be about the maximum depth consistent with good operative requirements.

Partition Walls, Slots and Overlaps

The minimum slope of the partition walls, (see Figs. 2 and 5) should not be made less than 1.2 vertical to 1 horizontal, the writers' practice being to make the angle with the horizontal vary from 52 deg. to 54 deg. (1.28 to 1 and 1.37 to 1) depending on conditions. They should be finished smooth in all cases. These walls have been made of precast concrete slabs, monolithic concrete, "gunite" slabs and wood, all of which have proven successful. The width of the slots varies from to 6 to 8 ins. and even 10 ins., although 8 ins. seems to be generally preferred by U. S. designers. The net overlap of the slot (see Fig. 5) should be at least 8 ins., although 10 to 12 ins. is decidedly better. There does not seem to be any advantage in going over 12 ins.

Inlets and Outlets

For a single tank, undoubtedly the best inlet is a single or possibly two ports, while the outlets in all tanks should be long weirs so as to minimize the fluctuation of water levels within the tank. When reversal of flow becomes necessary, the inlets and outlets must be exactly alike, and therefore have weirs at each end. In such cases again the weirs should be as long as possible and, in addition, ports should also be provided so that no deposits will occur in the feeding channels. Scumboards should be placed in front of the weirs to help distribute the sewage over the full cross section of the tanks and to retain the floating matter so that it may be skimmed off and disposed of. They should extend about 12 to 18 ins. below and from 6 to 8 ins. above the level of the sewage. They are usually made of reinforced concrete or cypress planks.

Channels

The design of the feed channels is important and the hydraulics and layouts for each case should be carefully studied. Velocities should be at least 2 ft. per second to prevent deposit. If there is insufficient gradient to produce this velocity it will be necessary to flush the channels during operation. Suitable stop planks or gates sliding in cast iron grooves should be properly placed to facilitate operation. All corners in channels should be rounded to avoid "dead places".

Sludge Chamber

Good U. S. practice calls for a sludge chamber with provision for holding from 6 to 8 months' sludge accumulations depending on climatic or other conditions. The chamber is either square or circular as the case may be, with either an inverted pyramid or an inverted cone forming its bottom. The minimum slopes for any element of the cone or pyramid should be 2 horizontal to 1 vertical, although the writer's practice has been to increase this slope to about 30 deg. with the horizontal, especially with square tanks. It is from the apex of the cone or pyramid that the sludge should be withdrawn, so as always to get the most thoroughly digested sludge. As to the quantity of sludge, Dr. Imhoff in 1915 recommended that the following sludge capacities in cubic feet per capita be used for U. S. practice:

	Separate System	Combined System
Small plants	2.4 (.01)	3.6 (.015)
Normal city sewage	1.2 (.005)	1.8 (.0075)
Sewage containing abnormal sludge-forming wastes	1.8 (.0075)	2.7 (.0113)

If we assume 8 months as the storage period (240 days) which is conservative and generous allowance, we have the figures in parenthesis as the per capita sludge production per day, for the various conditions. These figures are somewhat in excess of the old figures of .0035 for separate system and .007 for combined system as originally recommended by Dr. Imhoff. The writers, about 5 years ago, somewhat questioned these old figures for U. S. conditions and made certain investigations on sludge production at a small plant sewered on the separate system where the flow was 400,000 gallons per day. The results obtained there indicated that a figure of about .007 would be more nearly correct for separate systems under U. S. conditions. This figure was used by the writers thereafter, and practically recommended by Dr. Imhoff as shown above.

With a combined system it is essential to install a properly designed screen and grit chamber ahead of the tank in order to prevent the entry of inorganic debris and heavy grit to the tank inasmuch as such materials impair sludge digestion and clog the slots and the sludge removal pipes. With separate systems, screening is also advisable to prevent towels, shoes, brushes and similar materials entering the tanks. The clearance for screens will range from 1½ to 2½ ins. for the various conditions.

The capacity of the sludge chamber should be computed from a plane beginning at the edge of the deflector or even

possibly 6 ins. below it, which means that, during operation, the sludge level should not be allowed to rise above this point (see Fig. 5).

Sludge Removal

The sludge is removed while the tanks are in operation, by means of a 6 or 8-in. cast iron pipe extending into the apex of the hopper spoken of above. It is discharged by a differential head, which ranges from 4 to 6 ft. as judgment may dictate, the former being usually ample. The flow from the pipe is controlled by means of a valve on the end of the pipe. At Fitchburg, Mass., and in the new Philadelphia tanks, compressed air is used to remove the sludge from the tanks respectively to pipes and to channels located above the sewage level, and in which it then runs to the drying beds. A pressure water piping system should be installed for loosening the sludge on the sides of the hopper bottom of the chamber and also at the mouth of the sludge pipe.

Certain Characteristics of Some 10 Large American Tanks

The depth below the surface of the sewage of a number of the larger tanks in the U. S. ranges from 21 ft. to about 30 ft. The widths range from 18 to 40 ft., while the lengths range from 60 to 100 ft. Most of the tanks have the multiple settling chambers referred to above.

The volume of the settling chamber ranges from 30 to 50 per cent of the total volume of the tank, while the volume of the sludge chamber is about 25 per cent of the total volume of the tank. The volume of the gas vent above the slots ranges from 50 to 75 per cent of the volume of the sludge chamber, while the superficial area of gas vents ranges from 4 to 20 per cent of the top area of the tank.

These figures indicate the wide range of the designs due to the diversity of the U. S. conditions, but may help to give some idea of tank proportions.

The above figures for large U. S. tanks are from data recently compiled by the Bureau of Surveys of the city of Philadelphia, with which one of the writers is connected in the capacity of assistant engineer.

The foregoing represent, in detail, the general essential principles governing the design of an Imhoff tank, all of which have been proven by experience to be essentially correct. But, as stated before, each design and the conditions surrounding it, must be carefully studied in every particular to obtain the best results. The general arrangement of tanks in relation to each other and to the other units of a treatment plant, depends generally on topography or the amount of space available for the plant. The structural designs, especially for economy, and the development of the details for following out the above rules are matters in which the ingenuity of the designer plays a prominent and important part.

The New Sewage Treatment Plant at Xenia, Ohio

By W. J. Sherman, of W. J. Sherman Co., Consulting Engineers, The Nasby Bldg., Toledo, Ohio

The city of Xenia had a population of 8,706, according to the census of 1910, as compared with 7,301 in 1890, indicating a gain of 1,405 during the two decades, or approximately one per cent per annum. Greene county, of which Xenia is the seat, is in a rich, rolling, agricultural country, with fine, large farms and a rather sparse population, viz., 71 per square mile, as compared with 117 from the entire state.

There is some manufacturing at Xenia, chiefly shoes, pa-

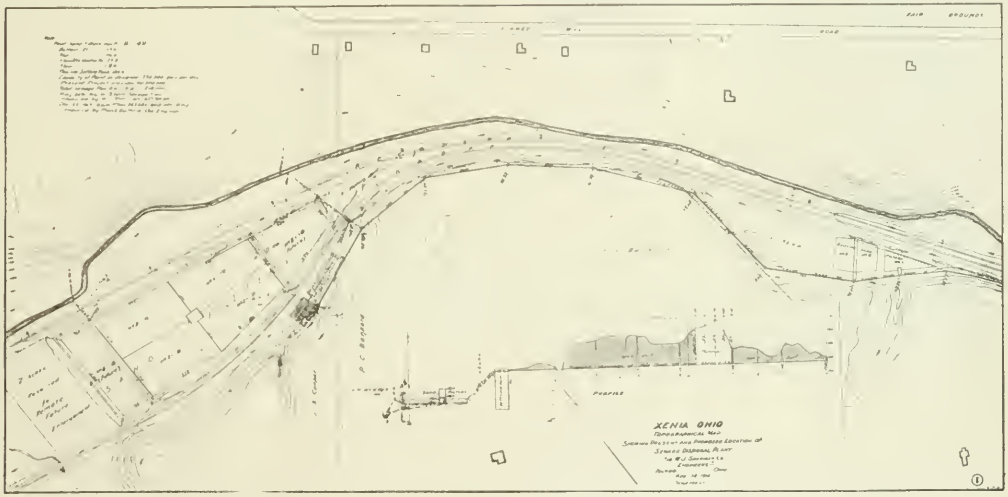


FIG. 1—TOPOGRAPHICAL MAP OF XENIA, OHIO, SHOWING LOCATION OF OLD AND NEW SEWAGE TREATMENT PLANTS.

per and machinery. The business of the place is dependent largely upon the rural districts for support.

First Sewage Treatment Plant a Failure

In 1901 a fairly complete sanitary sewer system was constructed, including a so-called sewage disposal plant, consisting of two small, shallow septic tanks with an aggregate capacity of 19,000 gals., and 1.47 acres of sand filters in four units. If well constructed, this plant should have easily cared for 185,000 gals. of sewage per day.

Poorly constructed as it was, its capacity was doubtless limited to about 100,000 gals. per day, whereas the total sanitary flow probably approximated 300,000 gals. per day. It measured about 350,000 gals. at 9 a. m., December 22, 1917.

The chief deficiency in the old filter was in the size of the plant and the next was the poor quality of the sand used in the filter beds. Besides, the installation has never been properly maintained, but, like so many similar ones, was utterly neglected by the city administrations from year to year. As a result the plant soon became a nuisance. As early as 1906 it was entirely abandoned, and in 1916 and 1917 a new one was constructed about one-half mile farther down Shawnee creek and about 8,000 ft. from the court house square. At this writ-

ing, March, 1918, it appears as though the contractor's delays, due to war conditions, would prevent putting the plant in commission before the 1st of May, 1918. The new plant is the subject of this article.

The New Plant

In brief, the new plant comprises a pair of Imhoff settling tanks, a sludge bed, a reinforced concrete control chamber and four acres of sand filters. Shawnee creek, on which both old and new works are located, has a drainage area of about 12½ square miles, a maximum flow of about 50 second feet, a minimum of 1 and an average of 4 second feet.

during the last two decades of about one per cent per annum, so there is hardly a likelihood of exceeding the capacity of the new plant for many years to come.

Details of Design

The relative locations of the old and the new plants are shown in Fig. 1, as is also the route of the extension of the main 20-in. trunk sewer from the old to the new plant. From the profile in Fig. 1 will be noted some of the construction difficulties in the sewer extension due to deep cut and tunnel work.

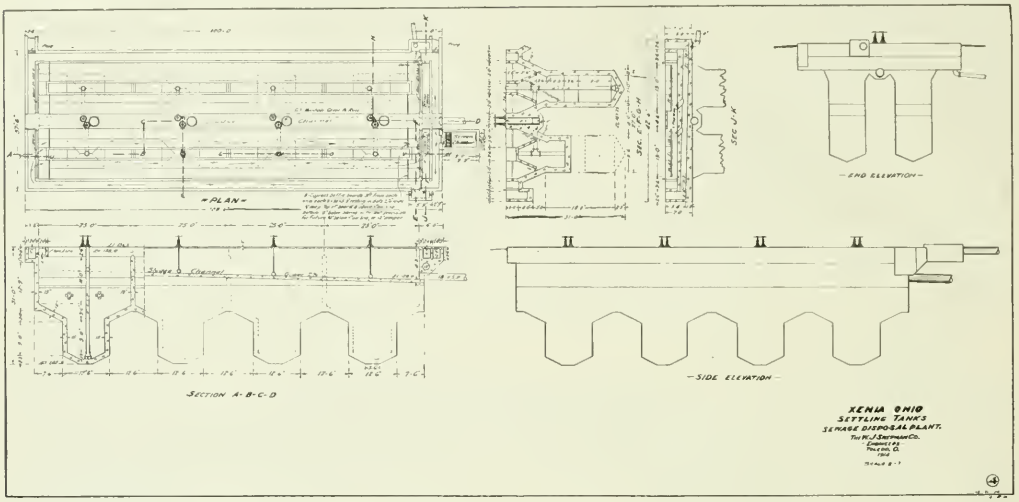


FIG. 2—DETAILS OF TWO IMHOFF SEWAGE SETTLING TANKS, XENIA, OHIO.

Fig. 2 shows a pair of settling tanks 37 ft. 6 in. by 100 ft., with eight sludge digestion chambers, screen chambers, weirs, baffle boards, channels for raw sewage and sludge, etc.

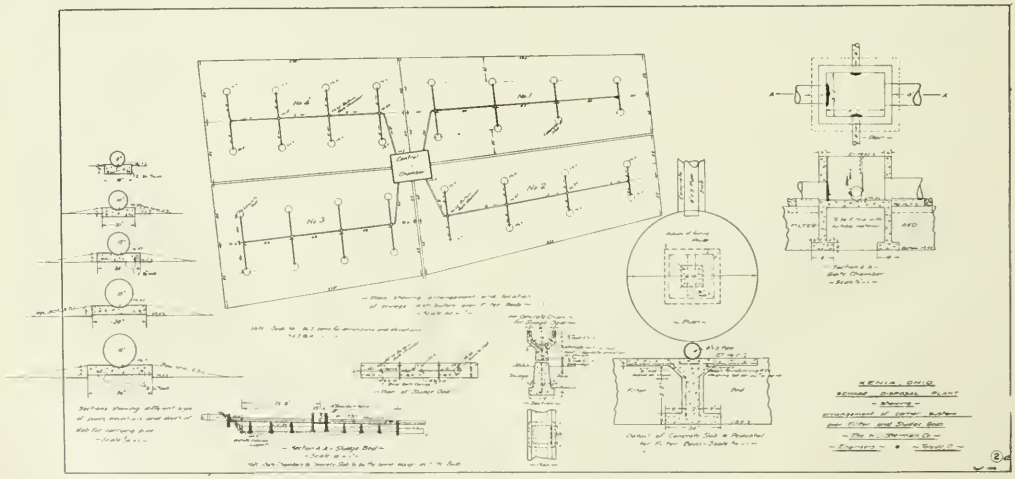


FIG. 3—ARRANGEMENT OF CARRIER SYSTEM FOR DISTRIBUTING SEWAGE AND SLUDGE OVER SAND FILTERS, XENIA, OHIO.

This plant is designed to care for a flow of household and manufacturing wastes aggregating 500,000 gals. in 24 hours, with provision for enlargement to 750,000 gals. in the future and to 1,000,000 gals. in the remote future.

We have already remarked on the slow growth of Xenia

Fig. 3 shows the arrangement for sewage and sludge distribution over the sand filters.

Fig. 4 shows the control works for the sand filters. Fig. 5

is a view of the plant as it appeared early in March, 1918.

The 20-in. trunk sewer was built of double-strength vitrified pipe and laid on a grade of 0.12 per cent. The entire plant will be operated by gravity, the topography of the land being peculiarly well adapted for such a layout.

The two-story settling tanks have a depth from flow line to bottom of sludge chamber of 27.75 ft. The upper or the settling chambers have an aggregate capacity of 8,000 cu. ft., equivalent to a two-hour detention period when treating 750,000 gals. per day, or a three-hour period when treating 500,000 gals. per day. The lower or digestion chambers have storage capacity of about 15,000 cu. ft.

Provision is made for weir measurement of the sewage as it enters the tanks.

The raw sewage is screened through ¼ by 1-in. bar screens spaced 1 in. apart.

Basis of Design

The sludge beds in three units are designed to provide an area of 0.43 sq. ft. per capita of total population, on the assumption that the volume of sludge will approximate .0035 cu. ft. per capita per day. The control or dosing chamber has a capacity of 11,000 cu. ft., with a flow line 7½ ft. above the adjacent sand filter beds. It is calculated that each dose of sewage will require about three hours for the 14-in. siphon to discharge, and that each bed will be flooded twice each day.

The specifications for filtering material call for:

24 in. of sand, 80 per cent to pass No. 20 and be retained on No. 40 sieve.

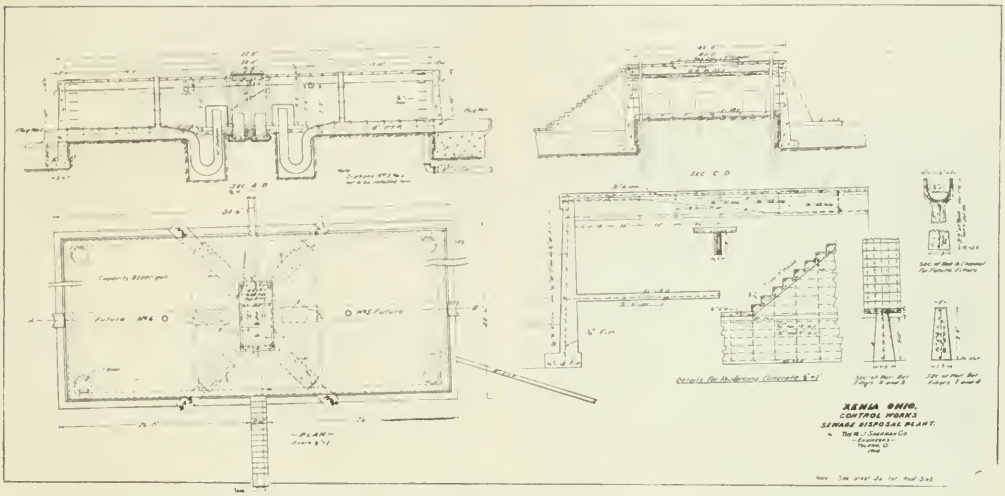


FIG. 4—DETAIL OF CONTROL WORKS FOR SEWAGE SAND FILTER BEDS AT XENIA, OHIO.

6 in. of gravel, ⅛ in. to 1 in.

6 in. of stone, ¾ in. to 2 in.

The carrier system was first designed for galvanized iron carriers, but on account of war prices (13c per pound), was changed to vitrified pipe resting on reinforced concrete slabs.

Contract Prices

The contract prices were as follows, viz.:

Item.	Cost.
Excavation in filter beds, per cu. yd	$ 0.40
Excavation in tanks, per cu. yd	1.00
Filter sand and gravel, per cu. yd	.80
Concrete in tanks, per cu. yd	15.00
Concrete in control chamber, per cu. yd	8.00
Reinforcing steel, per ton	110.00
14-in. siphons in place, each	550.00
20-in. sewer pipe in place, per ft	.85

FIG. 5—VIEW OF NEW SEWAGE TREATMENT PLANT AT XENIA, OHIO.

Trenching per ft., 30c for 6-ft., up to $9.70 for 32-ft.	
Manholes	40.00

Construction Costs

The construction costs have been as follows:

Trunk extension	$ 8,346.00
Settling tanks	19,102.25
Sludge bed	742.00
Control house	4,883.00
Sand filters (4 acres)	24,627.12
Lands and right of way	2,970.00
Printing and advertising	262.12
Contingencies and engineering	5,027.61
Total	$65,960.10

Personnel

The contractor for the plant was R. T. Bailey, of Dayton, Ohio; the resident engineer was Mr. Frank Guthrie, Cincinnati, Ohio; the designing engineers and superintending engineers were the W. J. Sherman Company, Toledo, Ohio.

Bridges and Buildings

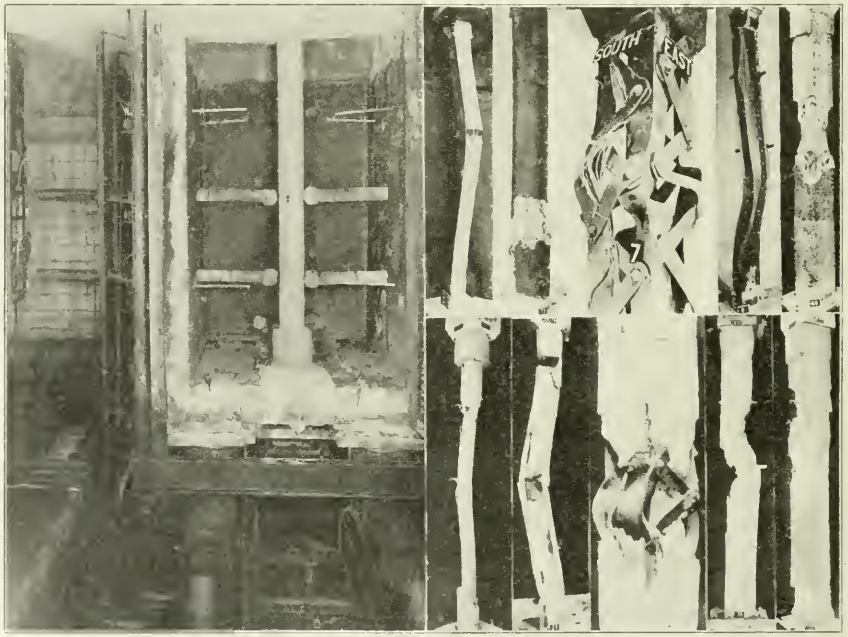
Apparatus and Procedure Used in Making Fire Tests of Building Columns

By W. H. Merrill, President Underwriters' Laboratories, Chicago

Fire tests of building columns, being jointly conducted by the Associated Factory Mutual Fire Insurance Companies, the National Board of Fire Underwriters and the Federal Bureau of Standards, at Underwriters' Laboratories, are progressing according to schedule, two columns being tested each week.

Apparatus Used

The apparatus used in the tests consists briefly of a gas furnace capable of being controlled according to a specified standard temperature curve, reaching a maximum of 2300 degrees Fahr. (1260 degrees Cent.) at the end of an eight-hour test. The load on the columns while being subjected to fire test is supplied by means of a hydraulic ram, an average load of 100,000 lbs. being maintained during the test, this being calculated for the various sections according to accepted formulas for working load.



TESTING FURNACE AND ACCESSORIES WITH COLUMN READY FOR FIRE TEST. EFFECT OF LOAD AND FIRE ON SOME SAMPLE COLUMNS TESTED.

The work of testing began last summer and will require a year for the completion of the full series of 100 tests. This was preceded by several years' work in designing and erecting the testing apparatus and in preparing and covering the test specimens by the different methods and with the various materials required for a full investigation.

Measuring Temperature

The temperature of the column furnace is measured by means of platinum and base metal thermo-couples, supported in porcelain tubes at two elevations; and that of the columns by means of base metal thermo-couples attached to the metal of the column at four elevations and at different points in the

section. The temperature indications are read with a potentiometer indicator and connections are also made to an automatic potentiometer recorder, so that graphic records can be obtained, if desired, of the indications of any set of couples.

Measuring Elongation and Shortening

The vertical compression and expansion of the columns, due to the load and heat, are measured over a gauge length of 37 in. in the upper half of the column by means of wires attached to the column at each end of the gauge length, the other ends being weighted and passed over an idler at a point outside of the furnace and as far from the column as room conditions will permit. The wires are protected inside and outside of the furnace by suitable insulating and protecting tubes. Readings of vertical movement are taken at intermediate points on the wires by means of microscopes mounted in micrometer slides, the true movement at the column being calculated from the distance relations of the microscopes and the fixed end of the wire, with reference to the point of attachment to the column. The lateral deflection of the column is measured by means of readings on scales placed perpendicular to and parallel with the wires.

A partial view of the testing furnace and accessories with a column ready for test is shown herewith.

Test Specimens

All of the tests are of full-sized columns of 12 ft. 8 in. effective length and of various steel sections, which are protected by concrete, tile and other forms of fire-protective coverings. One column of each type is tested unprotected; also several concrete columns reinforced according to methods used in current practice have been introduced.

Tests to Destruction

The tests are continued to a break-down of the sample, and hence no inferences as to the comparative merits of the various column designs and column coverings should be drawn from the illustrations, which show simply the effect of load and fire on a number of samples which have been subjected to test. The time required to obtain failure varies with the type of material and thickness of covering, the periods for the columns so far tested ranging from 17 minutes for the unprotected column to over eight hours for the heavier types of protection.

These the Pioneer Tests

This is the first work of this character ever undertaken employing modern forms of columns and methods of protection, and it is expected that it will develop data of great interest to city governments, underwriters, manufacturers, architects and engineers.

Specifications for columns and column coverings have necessarily been made ever since the advent of modern fire resistive construction, but there has been little or no experimental data as a basis for the various requirements promulgated, which in point of amount of protection required differ by more than 100 per cent. as between various city building codes.

Tests Will Lead to Rational Specifications

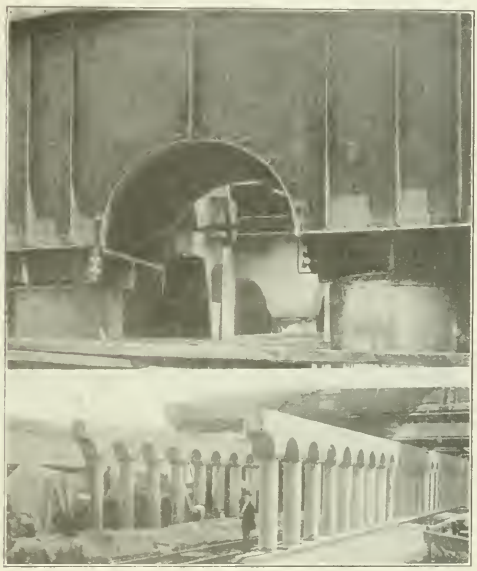
It is also thought that the tests will give much information on the general fire-resistive qualities of the covering materials employed. Differences in point of effectiveness of over 100 per cent. have already been found as between concretes made from different aggregates, some showing up unexpectedly well and others indicating decided unsuitability for use where the fire-resistive feature is a point of importance.

Successful Use of Built-Up Steel Concreting Forms on Track Elevation Construction in Chicago

The reconstruction of the Illinois Central Railroad bridges over the street crossings within the city limits in Chicago, incident to the track elevation construction, was begun in the spring of 1915, and has been carried through continuously without interruption to traffic to the present time. The work will probably be finished in the fall of 1918.

The railroad has purchased all forms for use on this work, but the placing of the concrete and erection of forms, etc., has been done by contractors.

In 1915 the John J. O'Heron Company of Chicago built six bridges, namely, over 113th, 111th, 109th, 107th, 105th and 103d streets. Each of these bridges contains three rows of columns and cross girders. Forms were furnished for two complete rows, 114 ft. wide. The columns are on 6-ft. centers resting on



VIEW OF BLAWFORMS USED ON TRACK ELEVATION CONSTRUCTION IN CHICAGO AND OF CONCRETE COLUMNS AND CROSS-GIRDERS CAST IN THEM.

heavy reinforced beams, which in turn rest on caissons 4 ft. in diameter, going down about 32 ft. to hardpan and bolled out in some cases to a diameter of about 8 ft.

In 1916 Bates & Rogers, contractors, built two bridges, one at 100th street and one at 82d street. In 1917 the Gould Construction Company built four bridges, namely, 67th, 65th, 64th and 63d streets.

As the work progressed nearer Chicago the width of the bridges was increased and at 63d street the width is 160 ft. In some of the crossings four rows of columns and cross girders were built and on some only three, but the contractor had at all times enough forms to set up any two rows.

All of the forms ordered since 1915 are now in use and are in good shape. The forms have been coated with light form oil after each use and the work obtained now is as near perfect as can be found. The forms have been used on an average of about 20 times each, and by the time the work is finished, next fall, they will have been used at least 30 times.

This work is under the direction of the Bridge Department of the Illinois Central Railroad, Mr. C. C. Westfall, bridge engineer. Mr. M. D. Thompson, assistant bridge engineer, is in direct charge of the work. The contractor in each case used a mixer on a car served with concrete materials in gondolas in the same train. Concrete was delivered from the mixer into wheelbarrows and from there into the forms.

Precast slabs made in Burnside, Ill., are being used for the decks of the bridges.

Speed in Fireproof Roof Construction

When the American Spiral Pipe Works, Chicago, commissioned Davidson & Weiss, the architects, to prepare plans and specifications for their new building, they advised Mr. Davidson that one of the most important factors was speed of erection. They had to have the building with as little delay as possible. This, of course, with safe and sane construction, and at a minimum cost. Mr. Davidson accepted the commission with this understanding, and within 50 working days after the plans were started the building was completed and turned over to the owners.

Some of the other requisites of this building were maximum light, maximum ventilation and a non-condensing fireproof roof deck.

Pyrobar gypsum long-span roof tile was selected as the roof deck material for this building, because it could comply with all these requirements and at the same time not cost any more than an ordinary non-combustible roof deck. Its light weight (15 lbs. per square foot) effected a considerable saving in the steel work, its low co-efficient of conductivity insured against condensation, its white undersurface materially added in the diffusion of light, and the ease and speed with which it could be erected guaranteed the roof deck being erected on time regardless of the weather conditions.

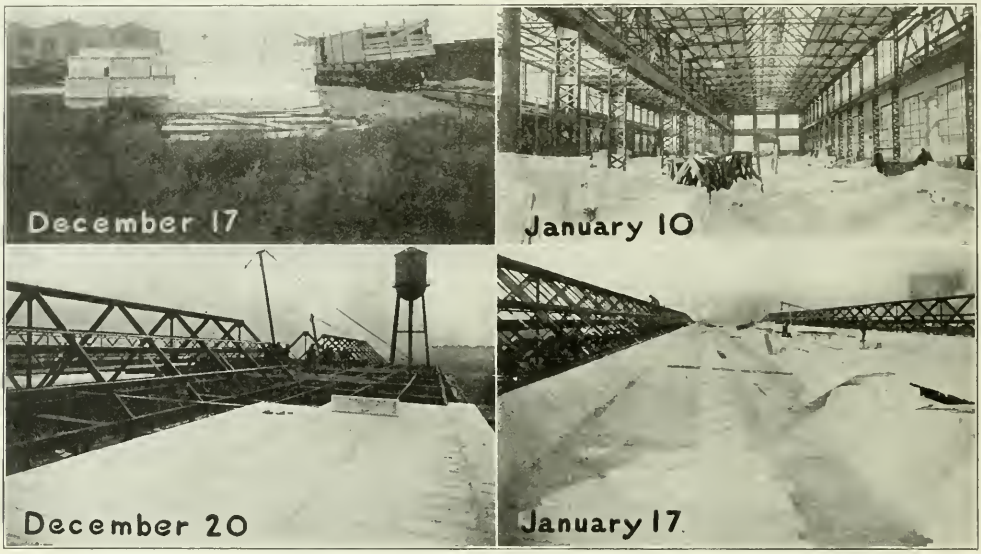
This building was erected in two of the coldest winter months, December and January, and in the early part of January one of the worst blizzards occurred that Chicago has ever experienced. This blizzard and cold weather did not delay the job, work continuing right through and being finished on time.

The accompanying views show (1) the tile on the job three days after receiving the contract; (2) the tile erected in place, and (3) the underside of the roof deck, 38,000 sq. ft. laid. Note the amount of snow inside the building; this gives some idea of the weather conditions that prevailed while the job was being erected. Finally (4) is shown the roof deck erected complete, ready for the roof covering.

Due to the decreased cost and the increased lighting and ventilating efficiency this type of building was adopted instead of the saw-tooth type. The purlin spacing being 5 ft., the standard stock lengths of tile were shipped, thus avoiding waiting for special lengths to be manufactured.

Where tile longer than 6 ft. and up to 10 ft. are desired they are molded at the building site. The "Structolite" (a specially prepared gypsum) from which the tile are made is shipped to the job in bags, where it is mixed with water to the proper consistency and poured into the molds. It sets in 15 minutes and can be removed from the molds in 30 minutes.

The United States Government, recognizing the conservation of steel effected by the light weight and the saving in time due to the speed of erection, has used over 2,000,000 sq. ft. of Pyrobar gypsum roof tile on recent installations.



VIEWS SHOW RAPID PROGRESS IN FIREPROOF ROOF CONSTRUCTION ON A CHICAGO BUILDING.

Iron Pipe "Twists Like Rubber"

After having been subjected to a torsional stress of 713,000 lbs., the piece of pipe shown in the accompanying illustration was found to be intact as to wall surface. No leaks were developed in the process, altho the pipe was twisted thru a complete turn.

The pipe on which this unusual strain was put was an 8-in. "National" line pipe weighing approximately 29 lbs. per foot. The walls are 1 3 in. in thickness.

From Workers in Field and Office

Practice in Thawing Water Service Pipes, Mains and Hydrants in North Attleboro, Mass.

Editor Municipal Engineering:

Sir—The North Attleboro Water Department, North Attleboro, Mass., like a majority of the water works departments in New England, has just experienced the most severe winter it has known. The frost has penetrated to a depth of from 3 ft. to 6½ ft., depending on the nature of the soil.

Depth of Freezing

During the past several weeks, starting December 24, 1917, several water service pipes of ½, ¾, 1 and 2 in. diameter were frozen, and later, in January, 1918, 6-in. cast iron water mains. The water department had a similar experience in 1912, when the frost penetrated to a greater depth than had been known up to that time; but in 1912 no 6-in. pipe was found frozen.

In 1912, the writer, manager of the Electric Light and Water Department, made up an electric thawing apparatus, consisting of a 20-kilowatt transformer, 2,300-volt primary and 110 and 220-volt secondary. This was an ordinary lighting transformer and worked very satisfactorily for all pipe up to 2-in.

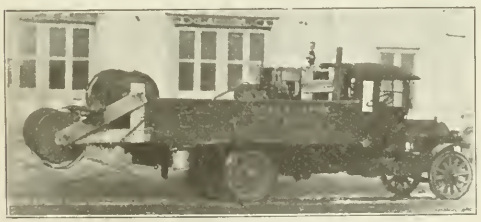
During the past winter the frost reached not only to the service pipes supplying residences, stores and factories, but to 6-in. cast iron water mains and 6-in. branch pipes leading to fire hydrants.

In the majority of cases where water could not be gotten through the hydrant, it was found that the branch pipe leading from the main to the hydrant was frozen. But the main itself was clear on account of the circulation of water due to water being used by consumers, leakage, etc., keeping the main from freezing.

Thawing Equipment

The Water Department provided equipment the past winter to thaw out any size pipe up to 8 in., including 7-in. barrel hydrants, and it has worked out satisfactorily.

The accompanying illustration shows a 3-ton Velie truck with the following equipment: Two 50-kilowatt General Electric Company lighting transformers, 2,200-volt primary and 110 and 220-volt secondary; an ammeter, General Electric Company make, 0 to 100 ampere reading, located at the top of transformer and connected on the 2,200-volt side of the circuit. On the front of the transformer, where the secondary or low voltage cables are located, there are mounted four single-pole 600-ampere fuse blocks, used for changing voltage from 110 to 220, or vice versa, and the 110 and 220-volt wires are connected to these blocks. Instead of fuses, heavy copper bus bar blades are used. The changing of the bars to get the desired voltage is made while the current is shut off.



VELIE 3-TON TRUCK EQUIPPED WITH ELECTRICAL EQUIPMENT FOR THAWING FROZEN WATER PIPE.

A large double-pole single-throw knife switch is mounted at the top of the left transformer, as shown in the illustration, which disconnects all low-voltage electricity to cable running into the house and fire hydrant.

Then 2,200-volt electricity is carried to the transformers on the truck and connected to General Electric Company primary cut-outs, which are located on the opposite side of the truck,

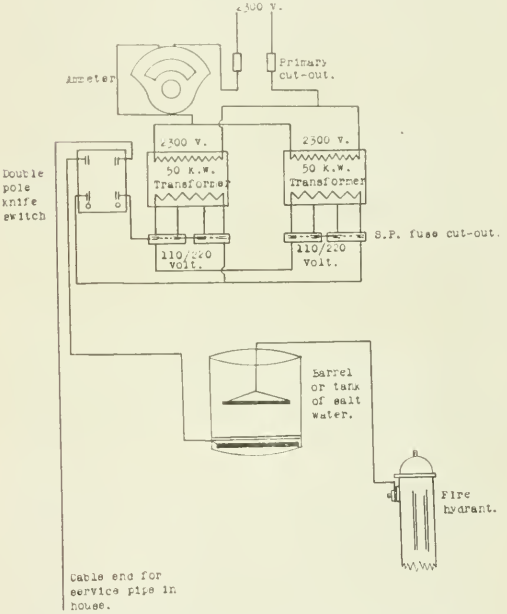


DIAGRAM OF ELECTRIC THAWING EQUIPMENT USED BY NORTH ATTLEBORO (MASS.) WATER DEPARTMENT.

as shown in the view. No fuses are employed in any part of the equipment. Current to the extent of 100 amperes on the 2,200-volt side has been drawn through the transformers.

One low-voltage cable is connected (see diagram) to a cast-iron flange, which is located in the bottom of an oil barrel, the barrel being half filled with water containing 4 lbs. of common table salt. The top cable coming out of the barrel is used to regulate the flow of current. On this cable is bolted another cast-iron flange 16 in. in diameter and 1 in. thick, this being lowered or raised by the hand of the man operating it, who at the same time observes the ammeter on the transformer, which indicates the amount of electricity in amperes flowing. If he is thawing with 110-volt electricity he simply multiplies the ammeter reading by 20, which will give him approximately the current on the secondary side of the circuit, which is the ratio of transformer, 2,200 to 110 volts, the current being practically in the same ratio, and if the 220-volt is used he multiplies by 10; by keeping the ratio of transfor-

mation in mind he can readily at a glance determine the flow of current he is using.

The 110-volt electricity is used on short services and the 220-volt on long services.

The two reels on top of the truck, as shown in the illustration, are 1,500 ft. of twin flexible insulated stranded cable; when customers with frozen services are beyond reach of the 2,200-volt primary circuits of the town's lighting system, then the twin conductor cable is laid on the ground to the truck.

Using the Equipment

The three bottom reels contain 1,200 ft. of No. 00 stranded weather-proof cable. This end of the cable is carried into the house and wound around the pipe, to make a good connection with the pipe to be thawed. The other end of the cable is connected to a short cable coming from the double pole switch. Two bolt guy clamps were used in connecting the cables together.

The end of the cable coming out of the barrel is fastened under the cap of a fire hydrant, thereby completing the circuit through the water main and the house service pipe (see diagram).

After the electricity is brought to the transformer in the truck, the main switch is thrown in, then the top cable with the cast-iron flange is lowered into the barrel containing the water; the farther this is lowered into the barrel, thereby bringing the upper plate near the lower plate, the greater will be the flow of current.

Great care must be taken on account of the kind of pipe to be thawed; i. e., an old plain iron or galvanized pipe cannot withstand as much current as a new pipe of a similar size, on account of the deteriorated condition of the threaded joints, unions and couplings, etc., which might burn the pipe off, due to unusual high resistance.

Time and Current Required

Lead service pipes ¾ in. diameter require approximately 300 to 500 amperes of current, while the plain iron or galvanized or cement-lined iron requires from 150 to 400 amperes, depending upon the size and conditions. The time required to thaw such pipe is about 5 to 15 minutes, and in some cases 20 minutes.

Six-inch cast-iron water mains require 500 to 800 amperes, and in some instances 900 amperes; 6 and 7-in. barrel fire hydrants, which is the ordinary 2-way or 3-way, 2½-in. nozzle type, require from 500 to 900 amperes.

In one instance it took only 15 minutes to thaw a 6-in. cast-iron water main, current flowing through the pipe 800 amperes at 110 volts. In another instance it required 1 hour and 10 minutes, with a current of 500 amperes, and at times raised to 600 amperes, at 220 volts; and another 6-in. main, 3 hours and 45 minutes, with a current of 500 to 600 amperes at 220 volts.

The difference in the time required was undoubtdely due to the fact that some of the mains were frozen a greater distance than others.

We also thawed 300 ft. of 3-in. wrought-iron steam pipe line running between two factories; the time was 15 minutes at 450 amperes, at 110 volts.

In another case we thawed a 5-in. cast-iron sewer pipe running between two buildings; the time required was 45 minutes, with a current of 540 amperes at 110 volts. The cable was connected or twisted around the iron pipe in one of the buildings and the other end of the cable on the sewer soil pipe in the other building.

Organization of Crew

Our crew consists of nine men, as follows: Two on truck operating main switch and cable in the barrel; one lineman, who connects all wires to the 2,200-volt lines; one hydrant man, who sees that the cable is properly secured under the cap on the nozzle and sees that a good contact is made; two men in the cellar to connect cable on the pipe to be thawed, and also inspect all piping as to joints or whether the water pipes are laying on gas pipes or come in contact with any other underground structure, etc.; three men to pull cable and guard it when laid in the streets, also guarding the high-tension 2,200-volt cable. With this outfit we have thawed as many as 32 services in one day, and in each instance thawed out on an average of three consumers to a "hitch."

The frozen service pipes were not confined in any one particular locality in the town, but pipe was found frozen in remote sections of the town, as well as in the congested district. Most of the frozen services were found in coarse gravel and ledge and rocky soil, where the frost penetrated to a depth of 6½ ft. In hardpan and clay soil the frost penetrated only to a depth of 3 to 4 ft. The average cost, including all charges and depreciation on cable, which runs high in such cases, was approximately $8 per service.

The electric thawing apparatus has been used by the Water Department since 1912.

Very truly yours,

Wm. Plattner, *Manager*,

North Attleboro, Mass. Electric Light and Water Dept.

Military Highways Vital Element of National Defense

Editor Municipal Engineering:

Sir—Military highways are an immediate as well as a future necessity of the military establishment of this nation. Motor transport is a vital part of our scheme of National Defense, but without suitable highways upon which to operate it, it is as helpless as railroad rolling stock without rails.

A majority of our so-called modern highways have already become obsolete and their maintenance in condition to permit of the use of high speed motor trucks is an important consideration. Many thousands of miles of our roads are still earth, or light waterbound macadam and unless such of these as are main arteries of travel and important feeders are improved, will soon become as impassable under heavy traffic as were many of our trunk line railroads during the heavy snow storms of last December and January.

The present crisis is a national one. The present extraordinary traffic on our highways is the nation's business and is increasing in volume as well as weight every day. Only those in charge of the military defenses and necessities of the country are in a position to select highway routes of the greatest strategical value. Such routes must necessarily be speedily placed and maintained in serviceable condition regardless of state boundaries or finances. The federal government is now very properly directing rail and water transportation as a military necessity.

The control and maintenance of the right of way of motor transportation is also the nation's business as a military necessity.

Very truly yours,

Charles N. Forrest.

Maurer, New Jersey.

Why Hard-Surfaced Roads Should Be Built This Year

By J. Denny O'Neil, State Highway Commissioner, Harrisburgh, Pa.

I am not in favor of cessation of road building on account of the war. Roads are an economic necessity and, even in war times, I am sure that the state and the counties are justified in the construction of permanent roads, which will help to relieve the congestion of the railroads and, at the same time, work into a definite road system that will connect the important centers of population and also enable the farmers to get their products to market.

If we want to keep the people—particularly the boys and the girls—on the farms, so that they can produce foodstuffs necessary to supply our cities, we must give them good roads.

If we fail to do this, they will join the ever-increasing throngs constantly moving to the centers of population.

It is true that roads cost more now, but everything else costs more in proportion. Part of the increased cost of roads is caused by the fact that the cheap types that were constructed in former years will not stand up under the motor truck traffic of today. Truck traffic is increasing by leaps and bounds and it requires a much better type of road to stand this kind of traffic.

Belgian Engineers Want to Hear from American Manufacturers of Contractors' Heavy Equipment

Editor Municipal Engineering:

Sir—We are two Belgian engineers and are indebted for your address to our firm, Messrs. Landre & Glinderman, of Amsterdam, Holland, to whom, as to us, you have rendered many favors. We have communicated with you many times before.

The war having given us much leisure for three years, we have devoted our spare time to a thorough study of everything relating to pile driving, both pile-driving machinery and pile-driving theories, and have written a technical work in French, which will be published in Paris in a few weeks. We have described in this work a very great deal of machinery of Vulcan.

As our work is now on the verge of completion, we intend to proceed with our studies and to extend them to contractors' heavy machinery and equipment, such as: dredges, locomotive cranes, dump cars, cableways, pumps, concrete mixers, excavating machinery of all kinds, elevating graders and steam shovels.

Consequently we respectfully ask you to assist us, and facilitate our task, by requesting all the firms who advertise in your publication to send us such complete sets of their literature as they think would be of interest to us.

At the same time we would esteem it a great favor if they would allow us to reproduce in our book the figures we should desire to use for illustrations.

Very truly yours,

Edouard Noe,
Amsterdam, Holland,
January 18, 1918. Spuistraat 6-8.

We Must Improve Roads to Win the War

Editor Municipal Engineering:

Sir—Food production is urged as an absolute necessity for winning the war. This is not called in question by anyone and all loyal people will support the injunction to the utmost, but there is a well defined gap that lies between the actual production of food and where it is wanted for use. This gap is camouflaged in so many ways, embracing withal, the practical, the theoretical, the sentimental, possibly the ignorant, and I greatly fear, involving ulterior motives which, if not unpatriotic, at least bear evidence of selfishness.

What is the secret which influences a man to say regarding a road building project that it should be strictly limited to that which will contribute to the successful prosecution of the war or which is necessary for public health and welfare, and then, with seeming fear that such langauge scarcely bears sufficient force that there is added that local and personal interests must be subordinated to public welfare?

Has anybody ever suggested a warning against plowing corn more than two or three times, or limiting in the same way the cultivation of a potato crop, and if so, what on earth could be the motive for such a suggestion?

Can there be any difference in doing what is necessary for an economic crop production and that which in all its details makes for the largest crop at the least expense, or doing that which is necessary for the economic movement of that crop to where it is wanted? What sort of wisdom is it that undertakes to draw the line of difference?

Why then should there be an insidious attack against methods of crop movements the moment the bushel of wheat is threshed? Is there any difference at all between a sane and economic production of the largest number of bushels per acre and a safe and economic delivery of that which is produced and if there is a difference, wherein the difference?

Is it not proper to spend money to save money in the delivery of food as well as to spend money for the economic yield of production?

Is it possible that this question of highway improvement involves a theory of wastefulness, extravagance or lack of economy? Is there some kind of visionary sentiment that connects up road improvement with a lack of patriotism? Is it possible that any character of discouragement for road improvement emanates from a lack of loyalty to the country, or is it a fear existing somewhere that improved highways will demonstrate an economy in the movement of so large a tonnage that it will go further than an immediate contribution to public welfare or an abundant food delivery for war success by taking away from other means of transportation a share of haulage for which, by reason of custom, the water and railway have established an exclusive claim?

In other words, does anybody or any interest fear that the utility and economy of highway transportation will be demonstrated?

Will there be no new engines purchased? Will old engines be repaired? Are worn-out cars to be replaced? Are tracks to be re-ballasted? Are worn and broken rails to be continued in use? If so, and if not, why? Or, shall all the energy possible be employed to maintain transportation in a practical, usable condition?

Are the highways of the country to play any part in supplying transportation needs of the country toward maintaining its industrial and financial strength in competent condition to meet the financial needs of the country?

Is it any concern that two fundamentals need to be recognized at this time? The one is that the financial strength of the country results from its greatest activity and that stagnation does not require any circulating medium at all.

"Nothing to buy" and "nothing to buy with" stalk in close companionship. Is there any significance in the price of 50 cts. per peck for potatoes in the grocery store and 3,000,000 bushels rotting in the field; is there no hurry for auto trucks at the war front in France that they should stop to wallow in the mud hub deep on roads of Ohio and Pennsylvania?

If a system of repression is to be inaugurated, rather than one of stimulation, for the country's sake let it be directed towards the thousand and one things that respond only to taste, fancy, extravagance or luxury; but give impetus to the one great commercial need in this time of needed wisdom, the needed increase in transportation facility which is vital all the way along the line from the toiler in the shop to the soldier in the trench.

Only last week we were informed by a responsible and patriotic citizen of Illinois, that he could not get into market his 30,000 bushels of corn, though within 30 miles of idle meal and hominy mills. This story was emphasized by a market experience of paying 8 cts. a pound for corn meal.

"What might have been" possible both for the comfort of the people and their undisturbed business activity throughout Ohio, Indiana and Illinois, *if all the people* had been situated as detailed by a trustworthy man but a few days ago—saying "Though I could not buy in my own neighborhood a pound of coal and my family would have suffered greatly, I fortunately lived on a good road with a coal mine 40 miles away. An auto truck furnished what was lacking and I supplied myself with ample fuel."

No car, truck or wagon has been turned away empty from

the coal mines. But coal at mines, or corn in the field is worthless to the freezing and starving. The financial loss due to a lack of fuel during the past winter, would build all the roads and do all the repairing under contemplation for the year 1918.

It is not extravagant to say that due to the bad roads the 1917 corn crop will deteriorate in quality—that measured in dollars and cents will exceed the amount of contemplated road improvement for 1918. The great amount of damp and soft corn that would be saved, or saved in part by being put into the dryers will be destroyed by decay, if held in the cribs or field until the roads dry up. Shall not encouragement be given to curtail these recurring financial losses?

Remove the spy glasses and ordeal of inspection and limitations to which it is proposed to subject all road projects, under the injunction to limit the road improvement to such as are necessary for public welfare.

The sources that inspired the imaginative fear that some road might be built in these times that would not contribute to both military and public welfare are hallucinatory breeding spots for which we should have but little use in times demanding the most serious action.

With the losses to labor and capital, the discomfort of thousands of families, the disruption of business, the difficulty in moving military supplies, and the inadequate distribution of food, experienced and confronting us, what official, what community, what state is proposing to build a road that is not urgently needed for military or public welfare or both?

Cleveland, Ohio. Will P. Blair, Secretary,
National Paving Brick Mfgrs'. Assn.

Plant Units and Lay Outs

The Versatility of the Portable Air Compressor

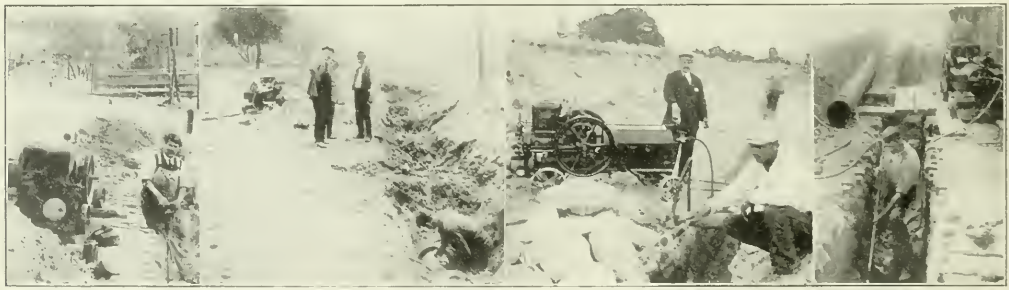
A Philadelphia gas company, that has been using portable compressors with a great deal of success, is responsible for the statement that there is no limit to the possibilities and accomplishments of these outfits. The accompanying photographs are confirmatory evidence of the truth of this statement.

In opening up a new trench for the laying of gas pipe, rock was encountered and immediately they put a Schramm rock drilling outfit on the job, the pneumatic hammer used being a one-man proposition. The steels were made of ⅞ in. hexagonal high carbon material. A smooth, straight hole passes down through the center, through which air is forced to blow out the chips. These drill steels can be swedged out on the end to drill a hole for receiving any standard stick of dynamite. No matter how narrow the trench may be, these outfits can handle the work with ease. With this outfit an average of 20 4-ft. holes (80 ft.) a day were drilled by one operator at the cost of the man's wages and 5 gals. of gasoline.

The trench being open, the pipe was laid and again the compressor was put to good use caulking pipe joints. This meant that the streets did not have to be kept open long, because the work was done in less than one-third the time it would have taken by hand. The joints were better made and only 3 per cent as many leaks appeared as when caulked by hand. The excavation did not need to be so large, because the caulker did not need to move about much. The operator is relieved of the strain of stretching or twisting over the joint experienced when trying to get a good chance to deliver the proper blow by hand. The pneumatic caulker can be held in either hand and the blow can be tempered down to any weight.

Another step in the operation was the testing of the pipe. The old way was to put several laborers on a hand pump and in this way the pressure was gradually raised with much effort. Oftentimes when the pressure was high enough for testing the joints, the men at the pump would become tired and the pressure would drop. By putting a portable compressor on the job and setting the unloader or automatic pressure regulator to the desired pressure, the machine will do the rest, enabling the men to continue testing all the time.

Now when the final stage had been reached and the dirt returned in the hole they found a still further use for the portable compressor. That was tamping down the earth. The work was done by one operator at the rate of 8 ft. in five minutes, in a ditch 3 ft. wide. The ground was so solidly packed that a pick was required to loosen it.



VIEWS ILLUSTRATING USES OF THE PORTABLE AIR COMPRESSOR.
Left to Right: Operating Pneumatic Rock Drill in Trenching—Caulking Bell Joint with Cast Lead or Lead Wool—Testing the Tightness of New-made Joints—Tamping Trench Backfill.

A Calculator for Proportioning Ventilating Duct Systems

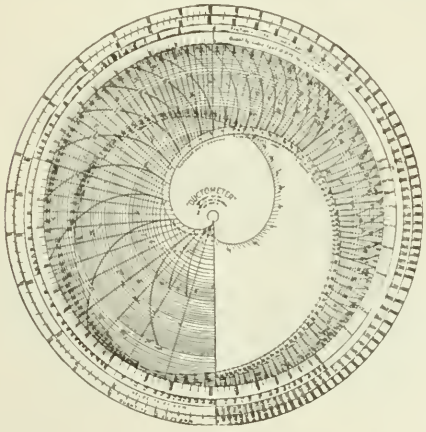
To proportion an air duct system by the use of arithmetical solutions of formulae is a long and tedious task, and it is the purpose of the Ductometer, here illustrated, to simplfy this work by using the common factors, such as: Quantity in cu. ft. A. P. M. velocity in feet per minute, sizes in inches and

frictions or loss of head in inches of water—to reduce the time of labor and retain the desired degree of accuracy.

The Ductometer consists of two discs 6 ins. in diameter, one superimposed upon the other and pivoted in the center.

The lower disc, which is opaque, has on it an outer scale, representing the quantity in cu. ft. A. P. M. to be delivered, which is used to find the dimensions of the ducts for area. A scale marked "friction in inches of water per 100 ft. of duct," which represents the loss of head due to friction. A scale marked "quantity cu. ft. A. P. M.—for friction," which represents the relation between the quantity A. P. M. and the frictional size of the duct, and is used to find the pressure as compared with a square duct. The curves represent the length of the side of a square duct; the diameter of a circular duct of equivalent frictional resistance as compared with a square duct, and the diameter of a circular duct of equivalent area, as compared with a square duct, respectively.

The upper disc is transparent, and has on it an outer scale, which represents the velocity in feet per minute; the



THE DUCTOMETER FOR CALCULATING PROPORTIONS OF VENTILATING DUCTS.

indicators, which represent the constants for frictional losses in ducts of smooth metal, rough metal, smooth plaster or concrete, rough plaster or concrete and brick, respectively, for air at 70° F.; an inner scale, which represents both the larger size of a rectangular duct, and the length of the side of a square duct, and an indicator curve. The calculations are based upon the formula in common use for this purpose.

The Chemical Method of Killing Weeds

To the average city the problem of maintaining weed-free streets during the spring and summer months is a vexing one. Weeds will grow where least wanted despite all that can be done to prevent it, and unless drastic measures are used, it is difficult to attain the ascendency of them.

Not only are weeds a sign of "poor housekeeping," giving the street an unkempt, uncared-for appearance, but they will actually ruin a paved street's surface if allowed to thrive in the interstices of the bricks or stones. The constant root growth will gradually lift even a heavy block out of position. If in the gutters, they will prevent proper drainage and collect filth and refuse, becoming a potent source of disease and contagion. A rank growth of weeds in a vacant lot covers many evils in the shape of debris, cans, rubbish, discarded raiment, deceased family pets, etc. Each of these weed-grown lots is a blot on the municipality and a constant danger to its inhabitants, which was proven during the recent epidemic of infantile paralysis.

With the arrival of weeds in May, comes the question: "How best can we get rid of them?" Labor is expensive and difficult to procure with present conditions. At the best, hand-weeding or cutting merely serves to keep down the growth for a week and the cropping renders the plant more sturdy and vigorous. Where weeds are pulled in dirt roads, a certain

METHOD OF APPLYING CHEMICAL WEED KILLING SOLUTION.

amount of the road material clings to the roots and is cast away; rains following cause washouts where the surface has been disturbed. With paved roads, the roots cannot be reached even with a cutting machine.

The chemical method has, therefore, proven attractive to many cities both from the standpoint of efficiency and its decided economy. The weed killer is mixed with water in a dilution varying from 1:20 to 1:40 and applied by means of a watering can or street sprinkling cart, with which extensive territory can be treated. It will sink into the interstices on paved streets and kill the roots. One application, it is claimed, at a cost of about half that of hand-weeding, will easily suffice to prevent weed growth for the season and eradicate most of the softer plants. The work should be accomplished preferably after the period of full growth has been arrived at, as the plant then lacks resistance and is more susceptible to chemical action.

There are a number of weed killers on the market. One of the most widely used, known as Atlas "A," is manufactured by the Chipman Chemical Engineering Company, Inc.

A Low Loading Mixer with Four-Motion Mix

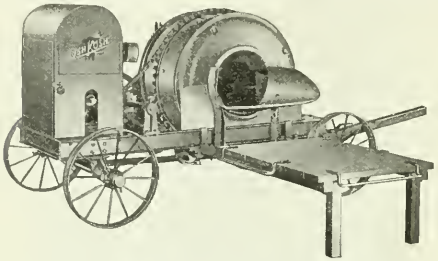
To the buyer of a concrete mixer, the four-motion mix has a value which should not be overlooked. This feature of the Ransome-Leach low-loading mixer, here illustrated, insures a thorough mix at a great saving in time, and as every user of concrete mixing machinery knows, the time element is of prime importance in the purchase of equipment and acceptance of contracts.

The four-motion mix operates as follows: When the dry material is dumped into the drum it is thrown against the paddles. As the drum revolves the paddles turn it over into the buckets, which carry it up an drop it on the inner end of the discharge chute. This throws the mix back into the paddles again and the operation is repeated. In this way the batch is split up and turned over four different ways all at once.

The steel blades or paddles, which are very heavy, are raised from the drum to allow water to run under, wetting the

whole batch quickly and keeping the drum washed clean. This four-motion method is speedy and thorough, producing a very smooth mix. The mixer turns out a batch a minute. Many users say it works even faster than this and produces a perfect mix.

Another way this mixer saves time is through its ease in loading and quick discharging. It has a low loading platform from which all material is dumped into the hopper from a



OSHKOSH LOW-LOADING MIXER.

wheelbarrow. The discharge chute is the proper height for loading into a wheelbarrow conveniently. Minimum time is required both in loading and discharging.

When desired, this mixer is equipped with a power-driven hoist for elevating the concrete. Power is furnished by the Novo engine, which is well known for its simplicity and economy.

Testing 25 American-La France Pumping Cars in New York City

Twenty-five American-La France pumping cars were recently delivered to New York City. Each car was subjected to a severe 12-hour underwriters' test. All of the 25 cars passed thorugh this test succesfully. These cars were guaranteed to deliver 700 gals. per minute at 125 lbs. pump pressure. The average capacity for all cars on all tests was 716.3 gals. per minute at 127 lbs. pressure.

The hose layouts for the tests were as follows:

125-lb. Test: Two 100-ft. lines of 2½-inch hose with reducing value in one line, siamezed into one 50-ft. length of 3-in. hose, with 1¾-inch nozzle.

200-lb. Test: One 100-ft. line of 2½-inch hose with 1¼-in. nozzle and reducing valve.

250-lb. Test: One 100-ft. line of 2½-in. hose with 1-in. nozzle and reducing valve.

280-lb. Test: One 100-ft. line of 2½in. hose with ⅞-in. nozzle and reducing valve.

All of this apparatus was subjected further to a rigorous road test over a 20-mile course selected to test the speed and hill climbing ability of the cars. All cars successfully completed every detail of these tests and passed the careful inspection that followed the tests.

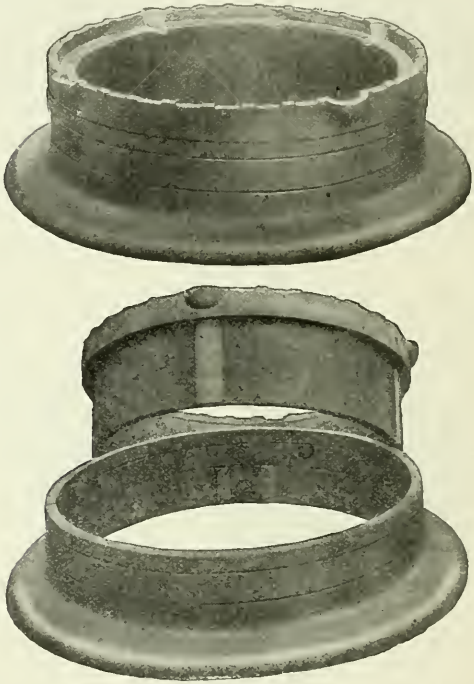
An Adjustable, Collapsible Manhole Frame

The adjustable, collapsible manhole frame here illustrated is made to allow the lowering of the frame to correspond with the ever-changing street surface without disturbing the road materials. This frame is of Daniels manufacture.

The upper member of the frame is made to telescope with the lower portion. A part of the retaining wall is made of solid iron rings having the same circumference as both the lower section and the upper flange, where the covers rest, and these are inserted between the upper flange and the lower member.

By lifting the upper section of the frame a ring may be removed and the frame replaced, occupying the space left by the removed ring. The traffic load is carried by the rings. The grooves between the telescoping member secure rigidity sufficient to prevent any canting or tipping of the upper member, it is claimed.

The ribs on the outside of the top member sustain the demountable wall against any crowding of the road material. At the time of rebuilding the street all the rings are returned and the top of the frame is at its original level. There are



VIEWS OF DANIELS ADJUSTABLE MANHOLE FRAME.

two rings in the recess, one 1 in. and the other 2 in. wide, so that 1 in. three times may be the range of adjustment. Rings of lesser widths may be used.

The frame is made for a standard cover 24 in. in diameter, with a clear opening of 22 in. for a ladder or basket. The two pieces will weigh from 260 to 275 lbs. without the cover. The two rings weigh about 50 lbs.

Loader Skip Saves Time and Money at Rahway, N. J.

The city of Rahway, N. J., saves with two loader skips $12.40 per day in salaries, 36 hours in time and gains 27 minutes over hand loading. These skips, of the Heltzel "Lightning" type, put a full load on a 3½-ton Federal truck in three minutes, on the average. George Geisel, in charge of this work for the city, reports that the loaders make the shovelers work more steadily. The force of shovelers has been reduced one-half since the loaders were purchased.

A Compact Five Legged Derrick.

Only two guys are needed to hold solidly a five-legged derrick that is used by a midwestern contracting company. The derrick is set up on a long, narrow frame, which also holds the engine. Two side-struts, one on either side of the mast, and two backstays set at an angle of about 30 degrees from the vertical, give the necessary bracing. The pair of guys make the rig an especially solid one. It is of particular advantage where working space is limited.

Advance Information on Big Jobs

Roads Reported to Washington by the States as Vitally Necessary to the Transportation System and as Aids to Increased Agricultural Production

Early this year it was determined by the U. S. Office of Public Roads and Rural Engineering that, so far as practicable, the federal aid funds shall be applied during the working season of 1918 only to the construction of such roads as are vitally necessary to improve the transportation system of the country, or to make feasible an increased output of important agricultural products.

The state highway departments were asked to formulate programs for the expenditure of all such funds as available for the working season of 1918 and such additional period as may be required.

The following specific information is based on the reports of many of the states to the Office of Public Roads and was sent direct to the editor of Municipal Engineering by the state official named in each instance. In some cases in addition to data, convincing arguments for road construction this year are given.

Florida

Wm. F. Cocke, Commissioner, Florida State Road Department, Tallahassee, writes:

"This department has prepared fourteen road and bridge projects for submission to the Secretary of Agriculture for improvement under the federal aid, three of which have already been submitted and approved.

"The total mileage of the proposed projects is 151, with the addition of one large bridge which will cost approximately $110,000. The types of construction contemplated are sand clay, gravel, asphalt macadam and brick. The sand clay and gravel surfaces are looked upon as temporary expedients, and it is expected to supersede them with more durable types of surface after conditions have become more normal. The brick will be used at such points where no local material can be obtained.

The two main trunk line roads on which the federal aid is to be applied are Road No. 1, Pensacola to Jacksonville via Marianna, Tallahassee, Live Oak and Lake City, and the portion of Road No. 2, from Lake City to Haines City via Ocala, Leesburg and Orlando.

Illinois

Clifford Older, Chief Highway Engineer, writes:

"In the schedule we presented to the United States Office of Public Roads, we included the following projects:

"Lincoln Highway, to be built complete from the end of the present improvement in Cook county through Geneva, DeKalb, Rochelle, Dixon and Sterling, to Fulton, Ill., in Whiteside county; the entire project to cost approximately $1,620,000.

"Dixie Highway, from the end of the present improvement in Cook county, through Will, Kankakee and Iroquois counties, to the end of the present improvement in Vermilion county; the entire distance to be improved; estimated total cost, approximately $920,000.

"Chicago-Wisconsin Line, from the end of the present improvement in Cook county northerly through Lake county to the connection at the Wisconsin line with a road being built from Milwaukee to the south Wisconsin line, affording an improved road from Chicago to Milwaukee. Approximate cost in Illinois, $745,000.

"Chicago to Joliet, Ill., complete improvement to be made at an approximate cost of $396,000.

"Peoria, north, approximately to Sparland. Improvement to cost approximately $370,000.

"This schedule of proposed improvements has been approved by the Director of the U. S. Office of Public Roads."

Indiana

Relative to the matter of military and main market highways to be constructed in Indiana during the present year, Wm. S. Moore, State Highway Engineer, writes:

"We have submitted to Washington about 200 miles of main market highway, which we would like to construct this year, and have set forth in detail the amount of cars it will take to ship the material necessary to do this work.

"The Indiana State Highway Commission, as you know, has designated a system of approximately 800 miles, and we consider this system as of military value, as it not only connects up the leading centers of population of Indiana, but it also dovetails into the leading systems of the adjoining states.

"We estimate that this system of 800 miles can be constructed in about four years. We have not been able to get the Government's approval on any of this work to date (March 12), but we except to receive favorable consideration and report from Mr. Page in a very short time."

Kansas

The federal aid road work financed to date in Kansas, as reported by W. S. Gearhart, State Highway Engineer, comprises eight stretches of road, as follows: (a) West from Dodge City on Old Trails Road for 11 miles; 20 ft. brick on concrete base; (b) east from Pawnee Rock on Old Trails Road for 27½ miles; 20 ft. brick on concrete base; (c) east from Wichita 7½ miles; 18-ft. concrete; (d) Parsons to Altamont, Altamont to Oswego, west from Altamont and south from Oswego, 44.5 miles, of 16-ft. gravel; (e) north, south (two lines) and west of Fort Scott, 39 miles, of 14-ft. macadam; (f) 57 miles of 18-ft. concrete on Golden Belt Highway east of Topeka; (g) 8½ miles of 18-ft. concrete southwest of Fort Riley, and (h) the road from Beloit to Glasco. The total estimated cost of federal aid roads now financed and those for which there is reasonable prospect for financing this year is $4,000,000.

Maine

Paul D. Sargent, Chief Engineer, State Highway Commission, Augusta, writes:

"On January 30 we forwarded to the Office of Public Roads and Rural Engineering, through District Engineer Miller, the recommendations of this commission with respect to federal aid work for 1918.

"Our recommendations covered the completion of Project No. 1, which was approved last year. This covers 15 miles of construction work on State Highway Q, in Richmond, Bowdoinham, Bowdoin and Topsham. Contracts for 10 miles of this work were let last season and about 2½ miles of road were completed. The State Highway Commission has entered into an agreement with the Secretary of Agriculture to complete the balance of the work, about 5 miles, located in Richmond.

"Our second recommendation was the construction of that section of State Highway H, located in Winslow and Vassalboro, about 13 miles in length. This will give a continuous

good road from New Hampshire along the coast, through Biddeford, Portland, Brunswick, Augusta, Waterville to Bangor and nearly to Bar Harbor, which is located in the town of Eden, on Mount Desert Island.

"The section of State Highway I, located in Pittsfield, was two-thirds completed last year under a state highway contract and the balance of the work in that location will be done by the first of July. The same is true of the short section of road leading into Bangor on the same state highway.

"The work completed by the commission last year on the "Coast Route" from Brunswick to Belfast closed all the gaps but the short section in Camden, which we are trying to build the coming season. All of the road from Belfast to Bangor is good, being a gravel-surfaced state aid highway."

Michigan

Frank F. Rogers, State Highway Commissioner, writes: "We are in receipt of your letter requesting certain information relative to the data which we furnished the Office of Public Roads and Rural Engineering, regarding certain highways to be improved in this State because of their importance at the present time and under present conditions.

"This schedule has already been submitted to the Federal Government covering the roads which this department proposes to build with the assistance of Federal Aid money. These projects embrace sections of road scattered in the various portions of the State.

"Michigan's Federal Aid law, passed to give assent to the national act, contemplated using this money to a large extent in filling the gaps in important trunk lines in the state, roads such as the East and West Michigan Pikes, which are a part of the Dixie Highway; the Mackinaw Trail, running from the Indiana-Michigan State line, north through the State and connecting with West Michigan Pike at Petoskey; the through State trunk line running from Detroit through Ann Arbor, Jackson, Marshall, Battle Creek, Kalamazoo, St. Joseph and west to Chicago; the trunk line known as the Wolverine Paved Way from Detroit through Howell, Lansing and Grand Rapids to Grand Haven, and other important trunk line routes in the Upper Peninsula.

"The projects which have been submitted to the Government and those which will be submitted, cover the improvement of a considerable number of these gaps. These improvements will not only facilitate local travel, but through travel as well, inasmuch as none of these projects are on roads which are not of first importance. Simultaneous construction on these roads will bring them to completion about the same time, which under present conditions is highly desirable so that continual interference with traffic on the main roads will be avoided as much as possible.

"At present only one Federal Aid road on the West Michigan Pike is under construction. The contract has been awarded on four sections of a project located on the Mackinaw Trail in the central part of the State and construction will begin at a very early date. Bids are being asked for (March 5) on three more projects within the next month. One of these, which is probably the largest road project ever undertaken at one time in the State, is located in Baraga County in the Upper Peninsula. The road is about forty-eight miles in length and connects the copper bearing district of Keweenaw Bay with the iron mining district of Marquette County, and by means of other state trunk lines, with the iron district of Iron and Gogebic Counties to the south, known as the South Range. This project is one of the most important projects in the schedule, being of prime industrial and military importance at the present time.

"Bids are also being requested on another project on the West Michigan Pike and on a portion of the road between Ann Arbor and Jackson, known as the Territorial Road."

Mississippi

Xavier A. Kramer, State Highway Engineer, Jackson, writes:

"The Federal Aid road improvement recommended for construction this year consists of several links on the main thoroughfares through the State, principally in the following counties. Ittawamba, Hinds, Rankin, Scott, Perry, Green, Kemper, Amite, Lincoln, Madison, George, Simpson, Wilkinson, Carroll, Montgomery, Marshall, Benton, Union, Pontotoc and Lowndes.

"The approximate cost is estimated at $750,000."

Montana

Paul D. Pratt, Chief Engineer, Montana Highway Commission, Helena, writes:

"The State Highway Commission of Montana answered questions in detail as submitted by the Portland office on twenty-eight projects. The projects were divided into three classes, in accordance with the amount of progress that had been made on their preparation for submission.

"The work proposed under each of the projects specified contemplates the improvement of the existing main roads in the various counties. The improvement of these roads is considered by the State and county authorities essential in the development of the various districts affected. The State of Montana as a State has made no provision for the supplying of the funds necessary to meet the co-operation required by the Federal Aid road act. Therefore the counties in which the various projects are located have, in planning their expenditures for the year 1918, made definite plans for the appropriation of funds wherewith to furnish such necessary co-operation, and a delay at this time in the prosecution of the work in the manner contemplated will seriously inconvenience both the state department and the counties in the performance of the season's operations.

"The State has expended a considerable sum of money in the prosecution of the applications listed, and if a delay is experienced much of the work proposed will of necessity be performed by the counties unassisted, and the expense thus incurred by the State will become of no avail.

"The improvements under all of the projects are for the primary purpose of providing cheaper and better transportation facilities for the marketing of the products of the various districts, and in no case can a project be considered non-essential to the industries of the state.

"The total costs of these twenty-eight projects is approximately $596,864.22. It is desired in all cases that 50 per cent. of the cost be borne by the Federal Government, though some of these projects will not be attempted before the season of 1919 at the earliest.

"Besides the projects definitely named, applications are in the process of initiation in the following counties: Lewis and Clark, Hill, Valley, Richland, Phillips, Chouteau, Cascade, Blaine, Sheridan, Rosebud, Custer and Park.

"These last mentioned applications are temporarily delayed, for various reasons. The project statements for the same will, however, be prepared as soon as obstacles of more or less a local nature can be overcome."

Nebraska

George E. Johnson, State Engineer, Lincoln, writes:

"I have submitted a schedule to the Department of Agriculture, showing the road construction that we expect to do this year. This schedule shows that we are preparing plans for 16 projects to cost approximately $1,280,000. All of the material is on the projects, for constructing same, excepting three projects. Ninety per cent. of these roads will be earth roads, and we are constructing same to give an outlet from the farm to the market. Incidentally, these roads are on our intercounty system connecting all county seats in the State."

New Hampshire

Frederic E. Everett, Commissioner, New Hampshire Highway Department, Concord, writes:

"Our recommendation to the Office of Public Roads and Rural Engineering as regards Federal Aid projects was for proposed construction on our authorized system of trunk lines.

"Following is a list of these projects with the contemplated amounts of expenditures:

Projects located in towns of	Approximate amount of expenditure contemplated	
Seabrook and Hampton Falls	$ 16,000.00*	No. 1
Marlboro	14,000.00*	No. 2
Colebrook	13,000.00**	No. 9
Gilford and Alton	15,500.00*	No. 4
Northwood, Nottingham and Barrington	15,000.00*	No. 5
Bradford and Newbury	12,000.00*	No. 6
Danbury and Grafton	20,000.00*	No. 7
Sunapee	12,000.00**	No. 8
Hill and Alexandria	16,000.00***	No. 10
Andover	10,000.00***	No. 11
Poterboro	9,000.00***	
Dublin	9,000.00***	
Canaan and Enfield	16,000.00***	
Epsom	12,000.00***	
Londonderry	12,000.00***	No. 12
Wolfeboro	12,000.00***	
Colebrook	15,000.00***	
Seabrook, Hampton Falls and Hampton	15,000.00***	
Total	$233,500.00	

*Approved project.

**Approval pending.

***Proposed project.

New Jersey

W. G. Thompson, State Highway Engineer, Trenton, writes:

"There is forwarded to you a summary of the work in contemplation for the coming season by the State Highway Department of New Jersey.

"This includes State work only, and takes no account of work to be done by the counties. These sections of routes were selected after careful consideration of the problem as it affects war transportation, and with the idea of affording maximum aid to the military establishment. They are sections of the State highway system recently established, and which comprise some 656 miles of highways, to be taken over from the counties, constructed and thereafter maintained by the State. Of the routes shown in the following statement, No. 13 is the one included in our schedule sent to the office of Public Roads and Rural Engineering, and is the only one on which Federal Aid is requested for this year. The other routes are to be constructed with State funds raised by a state-wide one-mill tax levy. New construction work to be undertaken with State funds during the coming season will amount to about $3,000,000."

The statement to which Mr. Thompson refers follows:

"On account of the scarcity of labor and the difficulty attending transportation, it will not be possible so to concentrate as to complete any trunk route in its entirety within the year. The money should be applied, therefore, to sections of such trunk routes as will accomplish the greatest benefit to the State, as affected by the war situation.

"The manufacturing centers of the State are furnishing war supplies of various kinds; its farms are providing food supplies needed for its manufacturing interests and for war purposes; the war situation will be assisted if easy and less dangerous egress and ingress can be given to the Government reservations within the State; a direct route should be provided across the State to the port of New York.

"In view of these conditions, I recommend that moneys to be derived from the tax levy be applied as follows:

"*Route No. 1*—This route carries a large percentage of the commercial traffic from Pennsylvania via Trenton and all points south and west to the great industrial centers in northern Jersey to the port of New York. The section between Menlo Park and St. George's Avenue, Rahway, paralleling the main line of the Pennsylvania Railroad, will provide a direct, safe highway, eliminating the dangerous grade crossings at Iselin and the many sharp curves on the present road between Iselin and Rahway. As Route No. 1 is heavily traveled at night by freight-carrying motor vehicles, the above mentioned improvement will make the entire route quite safe for travel day or night.

Route No. 2—This route is the shortest line between Camden and Trenton. Paralleling the Delaware River, it would form an outlet for vehicular traffic to Trenton or to Camden and Philadelphia from the many factories located along the river. There are steel and wire mills, brick factories and various other industries whose products are very much in demand. A section of the route from Bordentown southward is therefore included.

"*Route No. 3*—This route is the main trunk line for vehicular traffic to all points in southern and southwestern New Jersey from Camden, Trenton and the north, and with its feeders and lateral connections form an outlet to the northern markets for the products from the fertile agricultural districts between Camden and Absecon. It is now carrying heavy motor truck traffic, for which the present gravel pavement is inadequate, especially during winter months. The section proposed for improvement during 1918 is that leading south from the end of present bituminous concrete pavement at Berlin to a point south of Waterford Bridge.

"*Route No. 4*.—In view of the conditions outlined above, it is believed that filling of Mullica River meadows should not be considered for 1918 work and that funds should be expended on the unpaved portion of route No. 4 between Keyport and Red Bank, thereby providing relief for railroad short haul farm and industrial traffic in the district between Red Bank and the shipping points on Raritan Bay and contiguous waters. This, with contemplated improvements outside the State Highway system will also relieve and facilitate vehicular movement from and to Fort Hancock and Sandy Hook and adjacent territory.

"*Route No. 6*.—This route forms an oulet for the productive agricultural region in Gloucester, Cumberland and Salem Counties, for supplying of food products to the densely populated centers of Camden and Philadelphia, which with the development of the shipbuilding industry along the Delaware River and consequent increased transportation requirements, will tax the railroads to the utmost during the coming year. A steady stream of food laden vehicles travels this road, which at present needs improvement, warrants improving the section between Mullican Hill and Woodbury.

"*Route No. 9*.—This route provides the shortest line for vehicular traffic between Phillipsburg and all of its neighboring industrial activity and the industrial centers of Newark, Jersey City and the shipping points on the Hudson River and the New York Bay. Grading and paving of the only unimproved section of the route, namely over Muscanetcong Mountain between West Portal and Perryville, is desirable. With this improvement a means will be provided for rapid vehicular communication between the steel manufacturing center of South Bethlehem, Easton and Phillipsburg, and the factories of Somerset, Union, Essex, Hudson and Bergen Counties. The absence of such improvement makes the route practically valueless for traffic at present.

"*Route No. 10*.—Inasmuch as there are at present only two approaches to the Hudson River from the densely populated and highly important industrial centers of the Passaic and Hackensack Valleys, both of which are now overburdened, one of which has sharp turns and prohibitive grades, the con-

templated improvement of the section of route No. 10 from Fort Lee Ferry over the Palisades to Anderson avenue is of great importance. It will provide a maximum grade of 7%, as against 13% and 16% on one of the existing routes. The motor truck traffic over these roads between the Passaic Valley and the Hudson River ferries in Bergen County is possibly the heaviest in the entire state, and considering the growing inability of railroads to cope with ever-increasing freight, will increase rapidly in volume and weight of loads carried. It is, therefore, very apparent that the importance of the improvement of this section of the route cannot be overestimated. It will afford connection to the upper New York harbor for the cantonment at Camp Merrit and lower plants in the northern and northwestern section of the state.

"*Route No. 13.*—The improvement of that section of route No. 13 between Kingston and New Brunswick will bridge the existing gap in existing pavements between Trenton and New Brunswick, thereby providing a direct, well-paved highway from the industrial centers adjacent to Trenton and the Delaware River to New Brunswick, thence by existing well-paved roads to the manufacturing centers north and east. This route being a part of the Lincoln Highway is well known and, therefore, heavily traveled. It is also the most direct line between Philadelphia and the Hudson River. Because of its present condition and the necessity for immediate improvement brings it within the work to be done during 1918.

"*Route No. 14.*—This route forms the only outlet for vehicular traffic from the United States Naval Station at Cape May. The existing gravel pavement has eight railroad grade crossings within four miles. A number of deaths and serious accidents have occurred during the past two years which render the elimination of these crossings of primary importance. The improvement of this section will provide a hard pavement, making the naval station accessible at all seasons of the year, and obviate the present dangerous conditions from Cape May City to a point known as the Sally Marshall Crossing."

Rhode Island

I. W. Patterson, Chief Engineer, State Board of Public Roads, writes:

"Two sections of state highway are planned to be built under the Federal aid road act during 1918.

"Both of these sections are upon the Shore Line route between Providence and Westerly, which highway forms a portion of the Atlantic Highway, so-called. These two sections of road are almost prohibitive to travel for a short time each spring. These two sections, furthermore, are the only sections between Providence and Westerly which are really bad at any season."

Tennessee

A. M. Nelson, State Highway Engineer, Nashville, writes:

"The work designated by the State Highway Commission in the schedule furnished the Federal government entails the improvement of roads No. 1, 2, 3, 4, 7 and 18, which gives us a connected road from Memphis to Bristol and from the Kentucky state line to the Georgia state line across the state of Tennessee respectively east and west and north and south.

"This is our program for construction for the year 1918, to complete the uncompleted portions in these two roads across the state in both directions."

Utah

Ira R. Browning, State Road Engineer, Salt Lake City, writes:

"Herewith are extracts of our recommendations in connection with Federal post road projects in this state during the current year:

"*Project No. 1.*—Castle Gate-Duchesne road:

"Length of miles to be improved, 45 miles.

"Present type of surface, earth, shale and gravel.

"Present condition, passable for light traffic and loads up to about two tons, except during the spring thaw or stormy periods.

"Proposed type of surface, shale, gravel and sand clay surfacing.

"Approximate total cost, $77,400.

"Approximate amount of Federal aid desired, $38,700.

"Materials to be hauled in by rail, 220 tons of Portland cement, 116-mile rail haul; 5 tons of corrugated iron culverts, 126-mile rail haul.

"Relation of proposed road to other important roads in affording needed transportation facilities—Connects the Midland Trail at Castle Gate with the Heber-Vernal road at Duchesne. Provides the principal outlet for a producing area of more than 100,000 acres of irrigated land and more than 1,000,000 acres of grazing land.

"Volume and character of present traffic, United States mail, parcels post and freight averaging about 110 tons per day passing over this road, also average of 25 passenger automobiles each day.

"Probable change and increase in traffic to follow construction, outgoing freight, including wheat, oats, potatoes, hay, wool, honey and other farm or ranch products, should double immediately after road construction is completed, and all traffic will have a substantial, steady increase.

"The definite purposes to be served by the proposed improvement, afford marketing facilities for farm and ranch products.

"The possible bearing of the proposed improvement on the war situation, will make available for rail shipment thousands of tons of foodstuff that could not otherwise be shipped profitably.

"Probable effect of delay in construction to the 1919 working season or later, retardation of development of this producing section and preventing a large tonnage from being marketed.

"Further remarks by State Highway Department, the State Road Commission pledged this road improvement if the farmers would take steps to increase production. The farmers are doing their part.

"This project is the only one as yet approved and, therefore, is the only post road project participating in Federal funds at this time. Other projects are generally of the same type as project No. 1 and are justified by nearly the same arguments, but with varying acreages and tonnages involved."

Washington

George F. Cotterill, Chief Engineer, Olympia, writes:

"The Washington State Highway Department has complied with the request of the Federal Bureau of Public Roads and made detailed answers to the questionaire on the schedule forms furnished. Detailed information was furnished on 12 post-road improvements now ready for progress as our 1918 construction program. These cover about 65 miles of permanent highway improvement, estimated to cost $450,000, of which $235,000 is available from state funds and $215,000 from the Federal post-road allotment to this state for the coming fiscal year.

"These twelve projects cover in every instance important 'missing-link' sections of 1 to 18 miles in length each on routes of trunk highways which have been established as the state system and upon which about 1,500 miles of systematic construction has proceeded during the past six years. Several of these sections are of strategic need as parts of military roads and all are of high economic value as serving food supply localities or as alternatives for railway transportation routes by use of motor trucks.

"This department has presented the importance of each of these pending projects and urged that there be no postponement of any of them. In the letter transmitting the schedule form answers covering these twelve projects in detail, it was stated by the State Highway Commissioner that:

"'I desire also to impress the fact, which applies to all these projects, that the state and county co-operating funds are already in hand and in several cases have been held over since last year. There can be no use of any of these funds for other purposes, no saving to taxpayers and the only effect of delay would be to hold these funds in their places of deposit out of use.'

"An independent investigation, with the idea of possible postponements or eliminations, was also conducted by Federal authority during February, covering our 1918 program for projects within and adjacent to national forests under Section 8 of the Federal aid road act. For reasons unnecessary to review no actual construction had been begun on any of these projects during 1917, hence the entire program is already one year behind.

"Nine projects, involving 68 miles of construction in sections of 2 to 12 miles length, making extensions and filling gaps in our state trunk highway system (crossing national forests on the Cascade and other mountain slopes between productive vicinities and their markets) have already received formal or tentative approval at Federal hands. Their estimated cost totals $500,000, of which $265,000 is available state and county funds (mostly held over from 1917 and all now in hand and usable for no other purpose) with $235,000 of Federal aid apportionment for the two past fiscal years and that commencing July 1, 1918. Most of these projects have been deferred from 1917 and all are ready for progress with the opening of the 1918 working season.

"While there is some difference between their relative importance, all have ample merit to justify immediate progress, and should only be postponed in case of demonstrated need for the labor, capital or facilities necessary for the acknowledged superior war supply requirements. The details as to each of these projects were thoroughly presented to the Federal authorities during February.

"Summarizing as to both classes of Federal aid improvements planned for the Washington 1918 construction program, the facts have been given to the Federal authorities which in our judgment demonstrate:

"1. That each of these 21 projects is on some main trunk highway established as part of the comprehensive state system, upon which consecutive construction has proceeded for six years to the extent of about 1,500 miles, fairly distributed over the large area of the state of Washington, and the highest usefulness of previous construction and other improvements now progressing from state and county funds is dependent upon the prosecution of these 133 miles of Federal aid projects.

"2. That only a slight percentage of materials requiring use of railway facilities will be necessary for these projects, practically all construction being from local materials not requiring any railway haul.

"3. That there is ample construction equipment, teams, etc., available for this work during 1918.

"4. That if all these projects proceed during the 1918 working season as planned, they will not require unitedly a working force at any time exceeding 2,000, and not averaging more than 1,000 throughout eight months; that this number of road laborers out of a total of at least 300,000 male workers in the state is such a small percentage as not to affect materially the labor situation; that the workers available for road work are of an age and class not under any call for military or naval needs or adapted for shipbuilding or other mechanical employment; that the rate of pay for unskilled road labor cannot by any possibility attract from any necessary industrial or other war supply work, except possibly some forms of agricultural labor, and if any emergency—as, for instance, during the harvesting season—should demand the service of these men they would be more readily available for that purpose if already mobilized on public work at known points close to our agricultural needs than if they had to be gathered and brought from scattered places of idleness. The ability to suspend public road work and transfer labor for any possible war supply emergency is an argument of itself for assembling labor on road work rather than for postponement.

"5. That the total of $500,000 of state and county funds, already taxed and collected from our people (and most of it lying idle in banks since last year), cannot be applied to any other purpose, but must await the $450,000 of agreed Federal aid for its co-operative expenditure; that unless the Federal government requires the use of this appropriation fund for superior war needs, there is no adequate reason for postponement of any of these projects."

Wisconsin

A. R. Hirst, State Highway Engineer, reports that the proposed Federal projects for this year total about 190 miles of earth work, about 70 miles of gravel, about 19 miles of bituminous macadam and about 45 miles of concrete or brick.

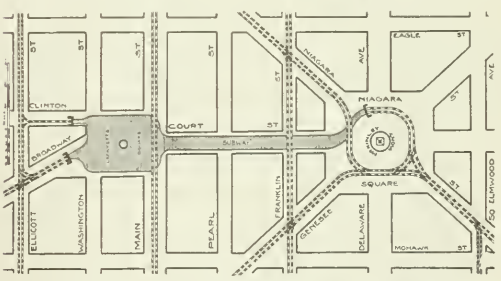
The Proposed Street Railway Subway Terminal for Buffalo, N. Y.

As one measure for relieving street congestion in Buffalo, N. Y., there has been proposed a street railway subway terminal. This sub-surface trolley terminal is proposed by the Traffic Ordinance Committee, of which City Engineer George H. Norton is a member. Its essential features are here illustrated and described.

The present central congestion, while somewhat due to the slow movement of numerous cars over extensive routes to facilitate convenient transfer, is mainly from the stopping and standing cars loading and unloading passengers. The street areas necessary for concentration of passengers adjacent to the cars is entirely lost as available for vehicular traffic, and the conflict of these two uses is largely the cause of the many street accidents. Could areas be found where this loading, especially of through or transfer passengers, could be made without highway obstruction, material relief would be given.

Conditions Indicate Need of Sub-Surface Terminals

These considerations point to terminals not situated on the surface of the thoroughfares. Some such terminals have been installed in various cities with good results, but where located on private property adjacent to busy streets the congestion caused by passage of many cars from street tracks into and out of such terminal buildings is destructive to all street travel in the vicinity.



PROPOSED STREET RAILWAY SUBWAY TERMINAL, LAFAYETTE SQUARE AND COURT STREET, BUFFALO, N. Y.

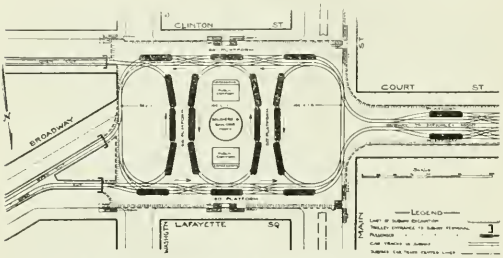
The ideal system would be for the cars to leave the surface tracks outside of the congested districts and pass to and through the terminals without obstruction of streets. This leads naturally to construction either above or below the street surface.

Influence of Topography

The peculiar topographic formation of Buffalo, where the main street congested district is materially higher than the territory on either side, points to a sub-surface terminal as most logical.

At present it does not seem warranted to make such terminal adequate to care for all cars in the central section, and the topography indicates the desirability of taking the east and west lines into such terminal and operating the north and south lines at grade over such depressed terminal.

The logical plan resulting from all these considerations seems therefore to be to operate the Elmwood avenue and Franklin street lines, Main street, Ellicott and Elm streets as



INTERIOR PLAN, SHOWING GENERAL SCHEME FOR CAR OPERATION, PROPOSED STREET RAILWAY SUBWAY TERMINAL, LAFAYETTE SQUARE AND COURT ST., BUFFALO, N. Y.

grade lines and to depress into a subway terminal the various Niagara street lines from the west, all suburban cars, and the radiating east side lines, Best, Genesee, Sycamore, Broadway, William and Clinton street, and perhaps some of the southeasterly lines.

The Plan

To meet the present conditions the following plan is proposed, its subsequent enlargement to meet increasing demands being outlined below.

The terminal to be located under Lafayette Square, utilizing the space from the westerly curb of Main street to the easterly line of Washington street and the full width of the square.

This construction can be so made as to in no wise interfere with the present appearance or use of the square, and would improve it to the extent of the removal of the car tracks now in Broadway and Clinton streets, between Washington and Main streets.

It will not be necessary to disturb the Soldiers' and Sailors' Monument as now erected, as the car loops here proposed would circle the existing monument and foundation and would not disturb the same.

The easterly entrance to this terminal to be by depressing the Broadway tracks from the westerly line of Ellicott street, passing entirely under the surface east of Washington street. The extra width of this street and the large natural slope from Washington to Ellicott street make this entirely practicable and easy without damage to abutting property. A single track branch outlet along the northerly curb line of Clinton street could be constructed and leave better surface conditions in this congested block between Washington and Ellicott streets. This terminal would be connected with the west side lines by a four-track subway through Court street to Niagara Square, the tracks rising to grade around the southerly and westerly sides of the monument by double track and meeting the existing grade tracks of the Niagara street line at the northwest corner of the monument space. These tracks would be not more, but rather less, obstructive to the view of the monument than existing surface tracks, as the cars would be below sight over a considerable portion of the distance.

This arrangement meets the requirements of getting terminal cars under ground without material obstruction of highways and allows continuous cross-town operation without interference with surface traffic in the congested district.

The location is the most central from the general geographical structure of the city and probably for traffic desiring to reach the heart of the city. The general plan of operation would be for several radiating east side lines to converge on Broadway at Ellicott, or beyond, pass into the tunnel, make a short loop and pass out by a similar route. West side cars converging on Niagara street, at the square, would pass into the subway at the monument and under Court street, make a short loop in the terminal and pass out by the same route. If found advisable, one or more of these lines could be made continuous between the east and west sides, passing through the terminal. Stairways on Main street and Franklin street would allow for transfers from these cross lines to the north and south lines at these points.

Future Development

This outlined plan should provide relief sufficient for some years, but can be readily extended. When the space under Lafayette Square proves inadequate, then a similar subway station can be provided under Niagara Square, some east side cars passing to this loop, west side cars passing to Lafayette loop, which will be possible over the four-track Court street subway. The next extension would be by subway in Main street or parallel street from Court street to a loop terminal at the Terrace for railroad station connection and transfer to the southeasterly lines, with a possible connection through Niagara street from the square to Main street subway.

A comprehensive study which has been made of the city plan strongly indicates the advisability of widening Clinton street as a great connecting arterial thoroughfare. There is, as a possibility, the construction of railroad passenger terminal facilities in the vicinity of Fillmore avenue. In case of such construction, reasonable transportation facilities would demand a subway connection with the heart of the city, and such might then be readily furnished through Clinton street to this proposed terminal.

These enlargements should be sufficient for all demands until such time as the growth of the city demands a general outlying subway system, of which these terminals would form a part.

Details

General studies indicate that the Lafayette terminal could provide space for simultaneous accommodation of 15 or 20 cars. As these cars would be arranged for loading from ground, as at present, it would be necessary to avoid raised platforms, etc., in the terminal. Prepayment of fares and issue of transfers would be made at a gate system on entrance and cars be loaded and unloaded through all doors, thus materially shortening the standing time in the terminal. No transfers would be necessary between lines entering the tunnel. Shelters should be provided at Franklin and Court and Genesee and at Shelton Square, with adequate public comfort stations. These arrangements would largely eliminate exposure to inclement weather in transfer and waiting for cars, now just cause for complaint.

The Proposed New Orleans Industrial Canal and Lock

By Howard Egleston, Engineer and Manager, Industrial Bureau, New Orleans, La.

Two conditions, one physical and one legal, have heretofore prevented New Orleans from becoming a great manufacturing city. The annual flood of the river furnishes the physical cause, and the organic law of the state, which makes all water front in towns and cities public property, furnishes the legal cause. The river rises at flood times about 20 ft., this has

made necessary the construction of great levees to protect the surrounding country from inundation. To protect these levees, the state has given power to the Levee Boards to expropriate any property that may have been erected on the water front. Under these conditions no industry could afford to build on the water front, and such as could be successfully carried on only in such locations, have gone elsewhere.

Canal to Connect Lake Ponchartrain and Mississippi River

This condition has been fully recognized for many years, and the Association of Commerce has constantly striven to carry through some plan that would give a sea level water front that could be permanently occupied. As a result a measure was brought before the legislature in 1914 and enacted into law, which authorized the Port Commissioners to construct a canal from Lake Ponchartrain to the river and connect with the latter by means of a lock.

$4,500,000 Available

Then came the war, and the Port Commissioners felt that if they completed the great cotton warehouses and built the new public grain elevator, they would be doing as much as was warranted, under financial conditions. But the demand for ships brought a demand for yards to build them in, and as shipyards cannot be placed on the banks of a river that rises periodically 20 ft. above its normal level, the plans for an Industrial Canal and ship basin into which ships could be launched any time, came to the fore again. The interest of all commercial organizations was aroused with the result that a financial plan has been worked out, and a contract made with a group of bankers by which the Port Commissioners have at their command $4,500,000 with which to construct the canal and lock.

The Lock

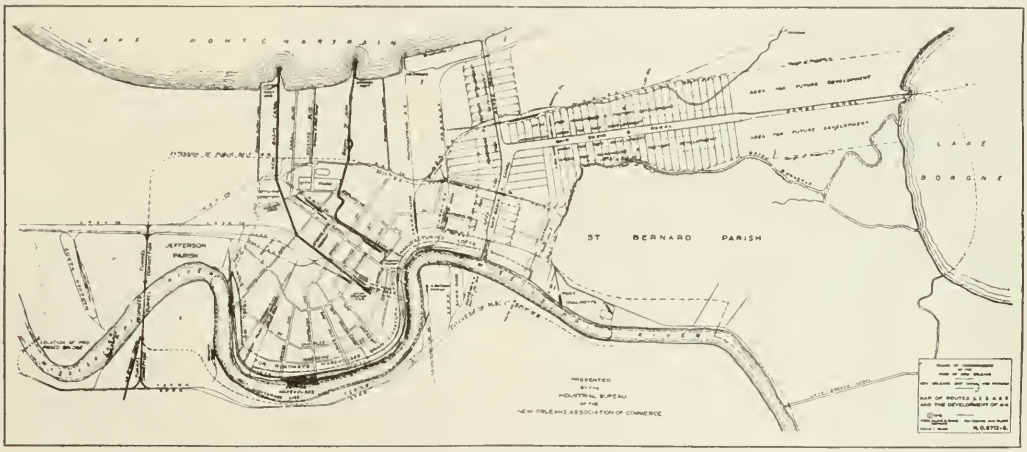
The canal will be located in a part of the city that has not been built up, though that portion of it near the river has all the city advantages of sewers, water, gas, electric light, street cars and telephone and will form a desirable residential location for the workers. As the reason for building the lock and ship basin is to get a location for shipbuilding, it is planned to make the locks only large enough to allow the passage of the standard steel ships the Government needs now, the intention being to enlarge the lock and canal so as to take in the largest ships that enter this port, at some time in the future when conditions warrant the expense. This may not be the wisest thing from a business point of view, but it is good patriotism.

The present tentative plan is to construct a lock 600 ft. long, 70 ft. wide, with a depth of 18 ft. at low water, over the sill of the lock. This depth will be the same in the canal as far toward the lake as may be necessary. The canal property at the lock, and extending for a mile or more, will be at least 800 ft. wide and the balance of the way to the lake, at least 300 ft. wide.

Main Canal 5.3 Miles Long

All the work of constructing the lock can be done before the water is let in, thus insuring better and quicker work. The work of excavating the canal from Lake Ponchartrain toward the river will be carried on by a large number of dredges while the construction of the lock is in progress, and at the same time, ships will be built and warehouses and shops erected. The canal will at first only extend from the river to the lake, a distance of 5.3 miles, but later on, a lateral extension of something like 8 miles will be constructed from about midway of the distance between lake and river to the east until the waters of the gulf are reached at Lake Borgne.

The completion of the canal from river to lake will give over 55,000 ft. frontage on the water, which may be increased to any extent by the construction of lateral canals. Thirteen thousand miles of waterway will bring the products of the fields and shops and mines of 21 states, containing 49 per cent of the total area of continental United States, to industries located on this canal, and make possible the export of finished products, at the lowest possible cost, to all parts of the world.


LAKE PONTCHARTRAIN
LAKE BORGNE
ST BERNARD PARISH
JEFFERSON PARISH
PRESENTED BY THE INDUSTRIAL BUREAU OF THE NEW ORLEANS ASSOCIATION OF COMMERCE

PROPOSED SHIP CANAL AND TERMINAL FOR THE PORT OF NEW ORLEANS.

$20,000,000 for Water Power Development at Muscle Shoals, Ala.

A water-power dam to cost from 15 to 20 million dollars will be constructed at Muscle Shoals, Ala., according to an order recently signed by President Wilson. The War Department was ordered to proceed at once with work on the project, which is a part of the plan for the construction of a government nitrate plant for the fixation of atmospheric nitrogen to be used in manufacturing munitions and fertilizers.

The dam site has been offered to the government without cost by the Alabama Power Company, which already has a contract to furnish 35,000 horsepower to the Muscle Shoals nitrate plant by June 1. The company has also agreed to transfer options on about 75 per cent. of the land which will be affected by the overflow from the dam.

The navigation of the Tennessee for the greater part of its

course is assured by the construction of the dam at Muscle Shoals, and this is expected to aid largely in the future use of the nitrate plant. The raw materials essential to the manufacture of fertilizer are all close at hand. Phosphate rock, limestone, coal and coke can be had in abundance, and water transportation will be available.

The total development proposed is 680,000 h.p. The initial development will generate 150,000 h.p.

Reports state that the power dam will be one mile long by 105 ft. high and that it has not as yet been determined whether to build by day labor or contract. Three years will be required to complete this power development, and pending its completion a 100,000-kilowatt, steam-driven electric plant will be built by the government to supplement 35,000 h.p. which the Alabama Power Company, of Birmingham, will furnish. This company's transmission system is now being extended and will be ready to supply Muscle Shoals by June 1. Surveys are progressing for the dam, and preparations are being made to begin construction, which will include an industrial city for the constructing workmen as well as for the permanent employes who will locate. Col. Charles Kelly, U. S. A., will locate at Muscle Shoals as engineer in charge of the power plant construction.

GENERAL ARTICLES

Procedure in Office of Construction Engineer, Employing Small Staff, Supervising Expenditure of $2,000,000 for New Improvements

By H. W. Skidmore, Construction Engineer, Department of Public Works, Oak Park, Ill.

In the four years just past Oak Park has spent $2,000,000 for new improvements—pavements alone costing $1,326,146.45. With a present population of 35,000, it would at once appear that Oak Park has been in the front ranks among cities of that size in the matter of public works.

This large amount of work has been handled by the department with a minimum number of men at a low cost. To do this it was absolutely necessary to weed out the nonproductive individuals and to put each phase of the work on a high plane of efficiency. This has been accomplished in spite of low salaries, "old-time" inspectors, etc. We have made our mistakes, of course, but a high standard of work has been maintained.

We have made many improvements in field and office methods during the past three years. The procedure in the construction engineer's department may be discussed briefly under the following heads:

Inspection

A comprehensive system of daily reports, which supply accurate information concerning all stages of the work; give locations, quantities and character of work done and materials used, contractor's force and rates, daily labor and material costs, etc., has been maintained and constantly improved. These reports are brief and ask for only such information as is really valuable now and later. They do not demand so much of the inspectors' time that his mind is distracted from his prime duty—seeing that the work complies with the specifications. These reports have been found to serve several purposes, viz., they supply the office with a permanent record of what transpired on the work; they provide accurate data from which to compile statistics, and they furnish records of underground work, which is in turn posted on the proper atlas, etc. Records such as these, when analyzed and compared with those of other jobs, contractors, etc., give us a keener insight into the efficiency of the various contractors and the character of the work done by them. They also serve as one means of "sizing up" the inspectors, since intelligent, accurate reports demand wide-awake, intelligent inspectors.

Inspectors are employed on each separate stage of the work, such as curb, grading, concrete base, etc. Inspectors showing particular adaptability to certain kinds of work are kept on such as much as possible. The force has been gradually rid of the less competent members, salaries have been raised and under close supervision a very efficient organization has been built up.

Frequent meetings of the entire force are held, at which times matters of both special and general nature are discussed, suggestions made and instructions issued, aims and methods defined, etc. Inspectors also attend the regular monthly meetings of the entire public work department. As a result of this practice the men have gained a thorough working knowledge of the various activities and regulations of all the departments, and consequently have rendered much co-operation in the matter of reporting irregularities and violations of ordinances and rules.

The writer, in co-operation with the chief inspector, has compiled and written a book of instructions and regulations for the use of inspectors and field men. This book is made in loose-leaf style and can be added to or changed at any time. It has been found to be of great value in the field, as it is well-nigh impossible for one to remember the practice in every case that may arise on a job.

Inspectors are provided with stars as a means of identification, and by virtue of these are enabled to command more respect when issuing instructions or warning violators.

Field Work

This work is done under the direction of the construction engineer, and comprises all preliminary surveys, field work during construction, final surveys and measuring, etc., which is incident to improvements; all field work necessitated by public uitlity construction and maintenance, park improvements and all field engineering connected with the activities of the Public Works Department in general.

The loose-leaf system of notes is used and has given excellent satisfaction because of accessibility of data concerning any given job and ease of filing; only one field book containing just the notes desired need be carried and any given set of notes may be left in the office for checking, extending and inking, without having to leave a bookful of other notes which may be needed in the field.

All preliminary and final work in connection with pavements, sewers, water supply, etc., is very carefully done, so that the resulting records eliminate any element of guesswork in designing and estimating and leave no room for doubt regarding quantities, location, etc., of completed work.

The field party is furnished with an automobile. This has enabled one party of from three to four men to handle as much work during the busy season as would otherwise require two to three parties.

Daily distribution is kept and yearly analysis is made of all field work.

Drafting

All the drafting work required by any of the departments is done in this office. One draftsman, who is also capable of doing instrument work, is employed all of the time, and during seasons of extra heavy work a second man is employed. We also make it a point to employ instrument men who are capable of doing some drafting and utilize them during bad weather and part of the winter months.

Preliminary or study plans are made for each job. Street lines and profiles are inked in, the other data being penciled on the tracings. After the layout and design has been made and the plans approved by the Commissioner, this study plan is made into a working plan, all of the information which was penciled on originally is now inked in. These working plans show all the details. After the ordinance has been passed a second plan is made, which does not show all of the details needed on the working plan. This plan is used in the county court at the time the assessment is confirmed. It has been found advisable to make this second plan in order to avoid the thousand and one questions that really have no bearing on the merits of the work in question, yet seem to afford the opposing attorneys much opportunity for delaying and even at times securing the dismissal of the improvement.

Final plans, which constitute a complete record of everything above and below ground, are made upon the completion of all work. The various atlases are also kept posted as the work is completed.

Daily distribution of drafting work is kept and analyzed at the end of the year.

Street Openings

The mileage of permanent pavements is constantly increasing and in direct proportion thereto is the increase in the number of openings in pavements. The economy of systematic regulation of pavement openings is well recognized by the profession today, and many cities have taken care of this feature in a very satisfactory manner. Until recently the practice at Oak Park was not very comprehensive, therefore, one of our first problems was here presented.

The methods and regulations employed by many other cities were investigated; the problem as it concerned Oak Park alone was analyzed, and then a report was made to the Commissioner of Public Works, pointing out wherein the existing methods could be improved and what new forms, regulations, specifications, etc., were needed. The report was adopted by the commissioner and is in operation today, though some of the minor details have not been fully worked out, and slight changes are made from time to time. It has been found that considerable educating of the public was necessary before any such system could be made to produce the desired results.

The matter of investigation, specification, regulation, inspection, repairs, records, etc., has been placed under the charge of this office. Since the engineering department is responsible for the building of pavements which will meet the requirements of modern traffic, it would seem that it should also have charge of the matter of opening those pavements.

Except in the case of macadam pavements (and not always then) we do not allow the permitee to make the final repairs to the pavement, unless it be an extensive piece of work which is being done by some public utility company, in which case we would allow them to do the work under our specifications and inspection. All repairs made by the Street Department are subject to the supervision of the office except as noted.

We employ one inspector who gives this work his entire time, if it is required. Such others as are needed from time to time are supplied from the regular force employed on new work. The nature of this work demands a very high-class man, because of the good judgment, accuracy in matters of locations and records, wide experience in all kinds of paving work, integrity, energy, etc., which experience has shown are absolutely necessary for proper handling of this very important part of the work.

Each opening made is insured against future settlement by thorough tamping and puddling of backfilled material (when excavated soil is not considered proper material for backfilling, cinders, sand, gravel or fine, dry earth must be secured for the purpose); by replacing concrete base, not less than 12 ins. thick, with bearing of 12 ins. on solid earth entirely around the opening, rich mixture—about 1:2:3—is used for all repair work, and reinforcing rods are specified at the discretion of the engineer. This practice is also followed in treating recently excavated trenches prior to all paving construction. We have never found that any trenches so treated have settled after the pavement was laid; however, before this method was adopted we experienced considerable maintenance due entirely to settlement of improperly reinforced trenches.

Fees charged for permits to open pavements are ample to cover the cost of repairs, inspection and other overhead.

Inspection of Asphaltic Pavements

Each year two very thorough inspections of all asphaltic pavements are made with the view of studying different types, under various traffic conditions, work of different firms, various materials used, etc. We have been, also, studying asphaltic concrete pavements in particular with regard to the decided tendency of such to crack. These inspections have shown conclusively that at least 98% of the cracks in surface material meant a crack in the concrete base, either directly under that in the surface or very close to it. We have found no cracks in this type of pavement laid on macadam base, and also found that sheet asphalt pavements do not crack as much as do asphaltic concrete, which fact we believe is due solely to the presence of a binder course.

The results of these inspections are posted on standard forms which include all the asphaltic pavements in the town, and give a complete history of each pavement from the time it was laid up to date. The inherent value of such a comprehensive record for the purpose of analysis and comparison is at once apparent.

Traffic Census

A traffic census has been taken on several of the heavy traffic thoroughfares, and will be taken on some of the other streets as well. These surveys will be repeated from time to time, for the purpose of studying the character of traffic, its frequency, changes, etc. This data, of course, will be used in designing future pavements.

Testing Materials

A small testing equipment was installed at the beginning of last year's work. It has proven to be a very valuable investment. Prior to that time much of the testing was left to the judgment of inspectors, and all of it was done by outside engineers. Owing to the cost of having this work sent outside the office, oftentimes analyses which probably should have been made were not considered important enough to warrant the cost.

While no elaborate analyses are attempted, only the simpler tests being made, still we have readily seen the value of such in the character of work done during the year. All analysis work incident to asphaltic pavements is handled by Mr. Lester Kirschbraun, Director of the Chicago Paving Laboratory.

In these days of rapid progress in all fields of construction work, intelligent analysis of materials, both in the laboratory and in the field, is proving to be a decided factor in insuring the best quality of work.

Card Record of Street Repairs

A system of card records of all street repairs, except macadam repairs, which are recorded by the Street Department, has recently been completed. These cards include repairs necessitated by street openings, general repairs and reserve maintenance. Each card gives complete data, such as location, size, kind of pavement and base, names, dates, etc.

While this record was very tedious to prepare, owing to the sad state of neglect in which we found the old records of some years back, once it was brought up to date, it has been found to require a surprisingly small amount of labor for maintenance.

Sewers

Many years ago, when Oak Park was a part of the town of Cicero, its sewers were designed as a part of the system which now drains several separate towns. The original design was made by a very capable engineer, who applied the then best-known principles, but many subsequent departures from the original plans were made by the various men who happened to be employed by the town from time to time. Then, too, at that early date not even the best sanitary engineer could have dreamed that Oak Park would develop as it has. Consequently our sewers are not of sufficient capacity now.

Until recent years sewers were built as needed, no particular attention being given to the compliance with any comprehensive scheme. They were simply given whatever size and gradient seemed to fit in with the existing sewers. The error of such procedure was at once apparent, for, even though some of the sewers built many years ago would never be able to serve the future, extensions which were to be made should have been designed to fit in with a scheme which would provide for some future relief plan. No rainfall or run-off data was available; in fact, the files for several years back disclosed no evidence that any theory had been applied to the design of sewers.

Consequently one of our first tasks was to collect rainfall data and compute run-off rates, etc. This was done and all the sewers which have been built in recent years have been designed large enough to serve future requirements and to fit in with a plan which the Commissioner of Public Works and the writer have had in mind for some time, for the relief of our congested system. Recently the writer made an exhaustive analysis of the situation.

During the course of construction of various improvements in recent years evidence of inferior workmanship and apparent very careless inspection, or none at all, has been uncovered many times. This class of work undoubtedly supplies one of the reasons why some of our sewers are so entirely inadequate.

Pavements

It is a significant fact that 85% of our roadways are paved and that about 32% is with asphaltic concrete. This type of pavement has met with considerable popularity among the property owners, because of its economical first cost and maintenance, its sightliness and cleanliness, and because of being practically noiseless. Experience has led us to believe that in some cases at least it would probably be better engineering to provide a bituminous base for this type of wearing surface, because of cost as well as in order to do away with the cracking tendency. A special mixture which was developed several years ago by Mr. Lester Kirschbraun and the Commissioner of Public Works is used and has given such good results that several other towns have adopted the specification.

All the brick pavements laid during 1917 were specified to comply with what is known as the monolithic type. On the first job laid we tried to live up to the letter of the specifications, but on those which followed we allowed the concrete to get its initial set, then laid the wire-cut block on a cement-sand bed. Because of the width of pavement, the great number of men who must walk back and forth over the work, and many other items of "workability," we have decided that the purely monolithic type, while its merits are not questioned, nor is its adaptability to the narrower highway pavement, is not best suited to the city street pavement of a varying cross-section, and laid by the present-day city paving contractor's organization, which is naturally much larger than that of the highway contractor, and owing to present-day labor conditions must be held intact for other work. Our specifications have, therefore, been changed to cover the cement-sand bed type of construction.

We have been laying a 6-in. concrete pavement in alleys with much success. These pavements are finished by means of the roller and belt processes. A few reinforced concrete pavements have been laid, but we are inclined to think that where the traffic is sufficiently heavy to demand this type of pavement a brick pavement should be specified.

It is interesting to note that the cost of maintaining pavements has been showing a marked decrease during the past few years. This is, of course, due to the replacing of macadam pavements with permanent structures. Also it is partly caused by the very large proportion of new pavements within the last four years; these new pavements naturally will not require much repairing for several years. Also it must be remembered that once these pavements do begin to show signs of wear and need some attention, such repair work will be evenly distributed from year to year, and will undoubtedly cost less per mile per year than the present rate, which still includes the maintenance of some 27 miles of old macadam roadway.

Inspection has been very close during the past four years and the result of this is readily seen in the class of pavements which have been and are being laid.

General

The several tables, charts, summaries, analyses, etc., which are prepared, are undoubtedly of value to the office in many ways, i. e., the analysis and summary of inspection costs on paving work is only an instance of such. These tables offer conclusive proof of our contention that those contractors who have incurred the highest unit inspection costs invariably do a poorer grade of work than those who, by good management, complete a given job in record time, thereby minimizing such cost. Such data as this is valuable as a permanent record of the year's work, and also of the work of successive years. It provides a mean of comparing the various contractors, and in many other ways offers valuable data to be used in the planning of field work, etc.

And so with much of the other data compiled. If such records were valuable only as a permanent record they would undoubtedly be worth the effort, but once such information is recorded and studied many unforeseen values are discovered. Moreover, the engineer in preparing such records gets a better idea of what he has been doing throughout the year, the results obtained, where improvements can be made, and so on.

In making improvements in old methods and in installing new ones, we have kept in mind that systems of records to be of value now and later must be maintained, and in their upkeep must not incur labor which cannot be handled by the regular force. It has been found that in working out some new scheme for doing this or that, while new duties were created for its upkeep, yet the maintaining of the scheme had so facilitated other office routine that in the end we had more time for new things. While "system" can be overdone, and its ramifications become so extensive that a top-heavy organization would be needed to keep things up to date, yet a certain amount of system and accounting of facts and figures will be found to be a blessing to many an engineering office.

Oak Park has existed as a municipality 16 years, having drawn away from the town of Cicero in 1902. During the last eight years it has doubled in population; the various activities of and demands upon the Department of Public Works have increased from 100 to several hundred percent, and many new activities have been taken on by the department, especially in very recent years.

In closing it is a pleasure to acknowledge the assistance received from other departments making up the Department of Public Works, without whose hearty co-operation it would

have been impossible for this office to have accomplished the results it has.

This spirit of co-operation is due in no small degree to the efforts of our Commissioner of Public Works, Mr. W. F. Sargent, who takes a deep personal interest not only in the work of the department, but in every member thereof, as well, and encourages every effort which makes for the development of the individual and greater efficiency of the department as a whole. Under his direction the department has greatly improved every phase of its work during these eight years. Mr. Sargent, himself an engineer of many years' experience, has at all times striven to put the department on a high plane of efficiency, employing sound engineering principles and good judgment in these efforts. He has surrounded himself with wide-awake young assistants of the producing type and has given them every opportunity to show their mettle and has constantly aided and encouraged them in every step which spoke for progress.

PERSONAL ITEMS

W. L. HEMPELMAN resigned his position as engineer in the service department of John Baker, Jr., Chicago, on February 1, and is now associated with the Pioneer Asphalt Company, with offices in Chicago. Mr. Hempelman was formerly engineer of bituminous pavements for the city of St. Louis.

W. E. ANDERSON has been appointed city manager of Brownsville, Tex., to succeed F. H. Williams, who recently resigned. Mr. Anderson is an engineer, formerly of Dallas, Tex.

DANIEL R. BREEN has been appointed superintendent of street repairs for Akron, Ohio. For some years he has been engaged in the municipal contracting business in that city.

RALPH M. ELDER has been appointed manager of the railroad division of the John Baker, Jr., Co., dealers in asphalt and bituminous products, with headquarters at the Chicago office of the company. He was formerly branch manager at Des Moines, Ia. He is a graduate in civil engineering from the University of Illinois, class of 1904.

D. R. LYMAN, for the past eight years chief engineer of the Department of Engineering of Louisville, Ky., has resigned. His resignation becomes effective April 1.

The STARK MOTOR TRUCK CO., Pittsburgh, Pa., are now engaged in selling Schacht motor trucks exclusively, although formerly handling contractors' heavy machinery also.

H. P. MARTIN, heretofore superintendent of streets at Dayton, Ohio, has been appointed public service director in that city and is succeeded by H. P. Ullmer.

MORRIS KNOWLES, consulting engineer, Pittsburgh, Pa., has been appointed chief engineer of the National Department of Housing. The engineering division will have supervision and co-operate in the design and construction of all utilities in the modern shipbuilding towns, including lighting, heating, water, sewerage, highways and transportation systems.

SAMUEL P. BAIRD and J. I. HUDSON have opened a consulting engineers' office at 8 E. Long St., Columbus, Ohio. They will specialize in the service of contractors, especially in the measurement of quantities and in the economical handling of construction. They will also carry on the usual engineering practice.

ROBERT L. HINCKLY has resigned as superintendent of the Rensselaer Water Co., Rensselaer, N. Y. He has accepted a position in the engineering inspection division of the Factory Insurance Association of Hartford, Conn.

CHAS. D. WEIRBACH, city engineer of Allentown, Pa., has resigned that office to become sanitary engineer for the U. S Government under the director of health and sanitation U. S. Shipping Board, Emergency Fleet Corporation. He will serve as sanitary engineer of the Hog Island Shipyard, Philadelphia; at Bristol, Pa., and at the plant of the Submarine Boat Corportation at Newark, N. J.

CLARENCE KNOWLES has been appointed city engineer of Johnstown, N. Y.

WM. G. THOMPSON has been appointed state highway engineer of New Jersey for a term of five years by the State Highway Commission. His salary is $7,000 per annum. He succeeds Robert A. Meeker, whose term expired on April 1. Mr. Thompson was engineer of construction on the Panama Canal.

EDW. E. REED, of Trenton, N. J., has been appointed assistant engineer of the New Jersey State Highway Commission for a period of five years at an annual salary of $5,000.

SAMUEL G. HARPER has been appointed city engineer of Portsmouth, Ohio.

THOMAS B. BERGEN has been appointed city engineer of Auburn, N. Y.

JAMES E. BARLOW, formerly director of public service of Dayton, Ohio, has been appointed city manager to succeed Henry M. Wait, who has entered the Federal military service.

JOSEPH KEMPER has been appointed city engineer of Utica, N. Y.

JOHN G. MARRON is now superintendent of streets and public improvements at Titusville, Pa.

ERNEST B. BLACK, of the firm of Black & Veatch, consulting engineers, Kansas City, Mo., has received a commission as captain in the finance division of the aviation section of the U. S. Signal Corps. He will have charge of the appraisal of property at plants manufacturing airplanes.

MAYO TOLMAN, chief engineer of the West Virginia State Department of Health, has gone to Guatemala in the interest of the American Red Cross. He expects to be on this mission for a period of three months to engage in relief work made necessary by the recent earthquake. He is on leave of absence and will at the end of the period resume his work in West Virginia.

HAROLD W. HORNE has joined the engineering staff of the Miami Conservancy District, Dayton, Ohio. Since 1912 he has been division engineer in charge of the construction of reservoirs and dams for the additional water supply of Hartford, Conn., and prior to that time he was section engineer for the Board of Water Supply of the City of New York, in charge of a section of the Catskill aqueduct construction.

JOHN R. KNEEBONE, of the city of Flint, Mich., city engineer's staff, has been appointed city manager of Beaufort, S. C. He was in the service of the city of Flint since July 1, 1916, latterly as cost accountant in the city engineering department. He is the youngest city manager in the United States. At Beaufort he succeeded Harrison G. Otis, who left that city to become city manager at Auburn, Me.

G. R. SOLOMON, of the firm of Solomon-Norcross Co., consultsulting engineers, Atlanta, Ga., has been commissioned as major in the Engineer Reserve Corps and assigned to the engineering staff of the Cantonment Division. His firm has been engaged on cantonment work for the Government since last April on a number of camps in the South and West. The general practice of the firm will be continued from Atlanta as heretofore.

JOHN CHAMBERS became city engineer of Louisville, Ky., to succeed David R. Lyman, who resigned. He was at one time city engineer of Louisville and was consulting engineer for that city during the construction of the new city hospital.

HARRY F. BASCOMB has been elected city engineer of Allentown, Pa.

Coming Conventions

UNITED STATES GOOD ROADS MACHINERY EXHIBIT—Exhibit at Little Rock, Ark., April 15-19. Sec'y., J. A. Rountree, 1021 Brown-Marx Bldg., Birmingham, Ala.

UNITED STATES GOOD ROADS ASSOCIATION—Will convene in Little Rock, Ark., April 15-17. U. S. Senator J. H. Bankhead, Pres. Sec'y., J. A. Rountree, 1021 Brown-Marx Bldg., Birmingham, Ala.

BANKHEAD NATIONAL HIGHWAY ASSOCIATION—Will convene in Little Rock, Ark., April 18-19. T. S. Plowman, Pres. Sec'y., J. A. Rountree, 1021 Brown-Marx Bldg., Birmingham, Ala.

ILLINOIS SECTION AMERICAN WATER WORKS ASSOCIATION—Tenth annual meeting will be held at University of Illinois, Urbana, April 16 and 17. G. C. Habermeyer, Urbana, Ill., Acting Secretary.

Trade Notes

Donald F. Whittaker, former assistant advertising manager of the Federal Motor Truck Company, for whom he was also engaged in sales promotion work, later taking the position of sales manager of the Detroit Truck Company, has been appointed advertising manager of the Acason Motor Truck Company, of Detroit, for which company he will also do sales promotion work. Mr. Whittaker is a former newspaper man who has scored success in the commercial field. The Acason Company, with whom he is now connected, has for three years had its trucks, ranging from 1½ to 5 tons, on the market in Detroit and Michigan, and more than 300 trucks have made good in that territory. The Acason Company is now arranging for a large national business, and recently announced the election of J. F. Bowman as vice-president and general manager. Mr. Bowman and Mr. Whittaker, with H. A. Conlon, assistant sales manager, are busily arranging distributing agencies throughout the United States.

The new $200,000 power plant of the Pawling & Harnischfeger Company, Milwaukee, Wis., will soon be in operation. This plant is up-to-date and modern in every respect. The principal equipment consists of two 300-h.p. Badenhauser water tube boilers, equipped with preheater and superheater, Bartlett-Grover water softener, 500-k.w. 220-d.c. Allis-Chalmers generator, and a P. & H. monorail coal-handling system for unloading coal from gondola cars and depositing it in boiler room bunker, from which it spouts to boilers and is fed by Sanford-Riley stokers. The forced draft is supplied by Sturtevant fans and engine. The equipment also includes a Nordberg poppet valve engine. The reinforced concrete stack, built by the General Concrete Construction Company, has a flue 6 ft. 6 in. in diameter and is 185 ft. high.

J. P. Newell, who for several months has been assistant sales manager of the Smith Motor Truck Corporation, Chicago, has been appointed to the position of general sales manager, succeeding Berry Rockwell, who took over the general sales management last June. Mr. Newell made his reputation as district sales manager in Colorado and the Rocky Mountain district.

Catalog Reviews

HY-RIB—Issued by Truscon Steel Co., Youngstown, Ohio. 5¼x7¾ in.—142 pages. Shows the use of Hy-Rib in roofs, floors, walls, sidings, partitions, ceilings and furring. Also as used in the construction of silos, tanks and conduits. Gives descriptions and properties of material. Shows many applications to a great variety of undertakings.

CONTRACTORS' EQUIPMENT—Issued by Oshkosh Manufacturing Co., Oshkosh, Wis. 8x11 in.—20 pages. Pertains especially to Oshkosh saw rigs, including "Eveready" portable saw rig and Oshkosh heavy portable rip and swing cross-cut saw rig. Also illustrates some additional equipment, including mixers, back fillers, trench pumps and building elevators.

GRAVITY CONCRETE PLANTS—Issued by Insley Manufacturing Co., Indianapolis, Ind. Catalog No. 41. 6x9 in.—64 pages. Illustrates and describes Insley gravity plant for concrete distribution. Shows all appurtenances and parts, as well as complete installations.

MOTOR TRUCKS—Issued by the Titan Truck Co., Twenty-fifth and St. Paul Ave., Milwaukee, Wis. Illustrates and describes the Titan truck in 5 and 6-ton capacities, as built for contractors and for heavy haulage service. 8½x11 in.—12 pages. Gives the reason for the production of this truck. Shows every part of the chassis in clear detail. Enumerates service features and gives specifications.

MOTOR TRUCKS—Issued by the Signal Motor Truck Co., Detroit, Mich., covering trucks of 1¼, 1¾, 2½, 4 and 5-ton capacities. Folder measures 4x9 in. Illustrates a number of trucks of the different capacities as operated by men engaged in a variety of business lines.

MOTOR TRUCKS—Complete operating and maintenance instructions for Service trucks, issued by the Service Motor Truck Co., of Wabash, Ind. 6x9 in.—64 pages.

SEWAGE DISPOSAL APPARATUS—Issued by the Sanitation Corporation, 50 Church St., New York, N. Y. Bulletin No. 4, Series G. 9x12 in.—22 pages. Illustrates and describes apparatus and equipment and complete plans for sewage disposal. It has special reference to the Riensch-Wurl sewage screen, also to grit cleaning apparatus, special valves, centrifugal pumps and reinforced concrete case pumps.

OXWELD APPARATUS—Issued by the Oxweld Acetylene Co., Newark, N. J. 6x9 in.—24 pages. Contains information about the use of the Oxweld process for cutting and welding metals. Describes apparatus and its operation in detail, with special reference to low-pressure generator, portable pressure generator, cutting and welding units, blow pipes, regulators and accessories.

MOTOR TRUCK HOIST—Issued by Young Patent Hoist Co., 31 Twenty-fifth St., Milwaukee, Wis. Bulletin No. 12. 8x11 in.—8 pages. Prices and operation and parts of Young horizontal hydraulic hoists for motor dump trucks. This dump body equipment is for use on any make of motor truck.

REINFORCED CONCRETE PIPE—Issued by Lock Joint Pipe Co., 165 Broadway, New York. 6x9 in.—124 pages. Shows construction and design of continuous reinforced concrete pipe of the Meriweather system. Gives list of users. Many handsome illustrations showing in great detail the proper handling of this class of pipe.

SCIENTIFIC BOOKS—Issued by John Wiley & Son, Inc., 432 Fourth Ave., New York City. 5½x8¼ in.—238 pages. A complete catalog of scientific books covering engineering, industrial and technical subjects.

EDITORIALS

Individual Merit of Proposed Public Improvements

Workers in the construction field will do well to grasp the fundamental principle in the attitude of officials of the Federal government toward making public improvements in war times. That principle, as we understand it, is that where a proposed improvement will aid in winning the war, or is clearly called for on economic grounds, it should be made; conversely, if an improvement will not aid in waging and winning the war or is not a clear economic necessity, it should not be made at this time.

Our understanding is based directly upon correspondence with officials of the Treasury Department. In a letter to the Secretary of the Treasury we recited that in our efforts to interpret the attitude of the Federal government relative to the construction of hard-surfaced roads we were so often thrown into confusion by conflicting press reports that we were moved to put this question to him direct: "Precisely what is your attitude at this time towards the construction of hard-surfaced roadways for utilitarian purposes?"

On direct instructions from the secretary his position was stated as follows: "Congress having passed the War Finance Corporation Bill providing for a Capital Issues Committee, there will be appointed in the near future (after April 5, the date of the letter) a group of men, which will be prepared to advise authoritatively concerning each individual case that may be brought to the attention of the committee. In the past the general principle upon which the committee has been proceeding has been that unless a military necessity exists, or there is a clear economic necessity, bond issues for road building should be postponed at this time. As stated above, however, each case will be examined on its individual merits, and it is very difficult to apply a satisfactory general rule."

It should be accepted without question that the construction industries are in the hands of loyal men. They, like all other right-minded Americans, want to conserve the nation's capital and resources, while increasing the production of wealth, and they also wish to encourage thrift. But, they should not be so foolishly unselfish as to prejudge their own projects to their own disadvantage. That is not loyalty; it is weakness. It may be downright disloyalty for those who best understand the value of good roads, for example, to cease working on road projects when they believe those projects are essential to the best interests of the nation at this time. Such projects should be pushed now more energetically than ever before, for never was the need for good roads so great as it is now.

While conceding to the Federal officials the desire to let business go on, there is no use ignoring the known fact that these officials are not omniscient. They understand some business relations better than others and they follow certain economic lines of influence more closely than others. Thus, while clearly appreciating the importance of railway transportation, there is no strong demonstrated reason for supposing that the officials of the Treasury Department have an at all adequate understanding of the value of highway transportation. It is for those who do appreciate the military and economic importance of hard-surfaced roads to work for these improvements without ceasing, for they can render no greater service than this to the nation at war.

In working for individual road improvement projects of genuine merit, for example, the worker may rest assured that he is not biased; others have reviewed the merits of such cases and have reached the same conclusions as himself. Thus, a recent canvass of the business men of the United States shows practically a unanimous belief that highway improvement is an economic and war necessity and that construction should proceed if the highways are to meet the traffic requirements of the country. Business men, generally, understand that it is a physical impossibility to expand the railway facilities rapidly enough to solve the transportation problem. The only hope of handling the freight of the country lies in the rapid development of highway transportation facilities. Obvious as this is to engineers, contractors and others who have long been familiar with the elements of the problem, officials at Washington simply do not appreciate the importance of highway transportation. If they did they would urge road improvements instead of merely granting their approval of individual projects.

Months ago the Chamber of Commerce of the United States endorsed road building as an economic and military necessity and at the latest meeting of that body the same interest was expressed in the development of highway transportation as a means of supplementing the railways. The popular press has been insistent in its demands that freight congestion be prevented, or at least relieved, by the transportation of freight by motor trucks over the highways. Men in the construction industries, therefore, need not hesitate to speak up for what they are in position to do for their country, for their services are wanted and their works are approved by their best informed fellow citizens. In this, as in some other matters, the administration officials are lagging behind public opinion. But, just as the officials have shown their ability to adopt the public viewpoint on other matters, so will they come to appreciate the wealth-producing qualities of certain public improvements if the educational process is sufficiently prolonged.

Very recently Secretary McAdoo said: "The successful financing of the war depends upon the difference between what is made and what is spent." There is no known way of adding to the public wealth that produces wealth any faster than the installation of improvement projects of high individual merit. Such improvements immediately begin to yield dividends to the public. The secretary has formulated a correct economic principle. Let us help him to see that a good application of the principle lies in the construction of improvements of merit. There should be no hesitancy in asking the Capital Issues Committee to pass on such improvements. It is our belief that the committee will act favorably.

Construction Costs After Other Great War Periods

Some local authorities are backward in initiating desirable improvements on account of present high construction costs. So far such authorities have thought only of present costs in comparison with those of recent years. They will do well to compare them with the probable costs of years in the near future. In this they may well be guided by considering construction costs in former periods following great wars involving many nations.

In the period of great wars covered by the French Revolution, the Napoleonic wars and the second family quarrel between this and the mother country, all the great nations were engaged in war. Students of economics and history assure us that during that period of approximately a century ago prices showed the same characteristics as during the present greatly disturbed period. All raw materials rose rapidly in price. Prices continually advanced until the end of the war in 1815. Then for about a year there was a sharp price reduction. This factor, added to the natural accumulation of work, again started prices upward, until they reached practically the maximum prices of the war, where they remained for about five years.

The same authorities state that during the series of wars including the American Civil War, the Crimean War, the Austro-Prussian War and the Franco-Prussian War, prices practically duplicated their behavior of the earlier period. Prices reached their highest level in 1874, three years after the close of the Franco-Prussian War, and did not return to normal until 1880.

In view of the foregoing facts public officials may well doubt the wisdom of postponing the installation of desirable improvements because of present high costs. Prices will hardly return to the pre-war level for a decade after the war. An improvement needed now cannot be postponed for a decade without public loss. Unless some other consideration than present prices is raised, therefore, there is no reason for deferring work of this sort.

Wheatless Days and Undrained Acres

At a time when the Food Administration is asking all citizens to observe wheatless days, and when efforts are being made to stimulate the production of wheat, it will come as a shock to many to learn of the vast acreage of lands lying idle or producing to poor advantage because of the lack of adequate drainage facilities. Citizens undoubtedly favor wheat conservation and wheatless days are observed cheerfully as a part of the individual contribution to the winning of the war, but citizens have a right to expect that the government will do its full part to increase production at the same time. This the government is not doing. It is quite as important to increase wheat production by reclaiming waste lands as to increase it at the expense of useful meadow and pasture lands and lands normally devoted to other crops.

In this issue we publish an authoritative article which states that construction work on drainage projects has been retarded by lack of equipment, material, supplies and labor, and that unless those in charge of drainage projects bestir themselves to obtain the desired assistance from the federal government, the outlook for land drainage for 1918, and probably for the next ten years, will be dismal.

The author states that the drainage situation is very alarming. It is the duty of engineers and others who understand the situation to present the merits of the land drainage case to the proper federal authorities and agencies. Engineers can make no greater contribution than this to the winning of the war, if there is truth in the slogan: Food Will Win the War.

How important this matter is will be at once appreciated when one learns that in 1910 there were 150,000,000 acres of tilled lands that were only 20 per cent. efficient because of poor drainage. In addition to this, there are about 80,000,000 acres of swamp and overflowed land in this country that are totally unproductive because undrained. A large part of this land could be made highly productive in a short time and at comparatively small expense.

Those who are informed in all the premises should use their influence on the Department of Agriculture, looking to the prompt and correct solution of this highly important war problem.

An Example of First-Class Engineering

The sort of engineering that grips the imagination while appealing also to technical interest, and, at the same time, shows what the professional engineer can accomplish when he adopts the aggressive methods of the progressive business man, is described in the article published in this issue, entitled, "Design and Construction of the New Municipal Dam and Hydro-Electric Power Plant at Fort Dodge, Ia."

The article is good from the technical standpoint, but certain features of the project and the methods employed in promoting it are of such unusual interest as to merit special comment.

The dam was built, first, to produce money from the sale of electric energy generated by water power, and, second, to create a lake to be utilized by the citizens for pleasure purposes. Undoubtedly the appeal of the second consideration to the taxpayer was what made the project possible of accomplishment. To an inland community like Fort Dodge the prospect of obtaining at home a lake for fishing, boating and bathing proved very attractive, as one can readily understand. That the project was fully justified from the financial standpoint is also at once evident from the fact that private interests sought franchise rights for its execution.

The engineers took a leading part in the campaign preceding the necessary bond election. They transferred their preliminary sketch plans, estimates and other data to lantern slides, which were shown and explained at mass meetings. This procedure acquainted the citizens with the merits of the project, appealed to the public imagination, and enabled the taxpayer to cast his vote intelligently. The result, easily anticipated, was the success of the bond election.

The engineer reader will not fail to note with appreciation the frankness with which the author discusses the difficulties encountered with floating ice shortly after the spillway section of the dam was finished. The methods successfully employed in overcoming the difficult situation thus produced, add to the article just the spice necessary to lift it above the level of the commonplace. Rarely does an article show modern engineering in a better light.

PAVEMENT DESIGN AND CONSTRUCTION

The Design and Construction of a Granite Block Pavement

By George W. Tillson, Consulting Engineer, Brooklyn, N. Y.

It is undoubtedly true that in the past highway engineering has been given less attention, according to its worth, than any other branch of the profession. Engineers have been prone to think that a pavement is a pavement, and no matter under what conditions it was to be used, to consider that any one material should always be treated in the same manner.

Tradition Long Arrested Development of Granite Block Pavements

This can be illustrated most clearly in the case of granite pavements. When first used the blocks were approximately 8 to 14 ins. long, $3\frac{1}{2}$ to $4\frac{1}{2}$ ins. wide and 7 to 8 ins. deep. These were laid on a sand base with the joints filled with sand. It was soon found that such a pavement would not maintain its surface under heavy traffic and a concrete base was substituted for the sand, the joints between the blocks were filled with tar and gravel, but the dimensions of the blocks were not changed.

A little thought should have made it evident that the large, heavy blocks used for stability on a sand base were not necessary on concrete and that the depth of 8 or even 7 in. was not required, as the blocks very seldom wore down to any great extent, but rounded off and so became too rough for use.

The writer feels free to make the above criticism as for 35 years he has been engaged in highway and street work and thinks that the remarks apply to himself as much, if not more, than to any one else.

But in recent years a change has come over the minds of engineers and they have recognized that the public not only demanded a better granite pavement, but was willing to pay for it. And it must be admitted that question of cost also has seriously retarded the progressive movement.

The advent of the automobile and the auto truck soon showed the necessity of a different construction on country roads and the study of those requirements naturally lead up to the question of improving city streets. Granite pavements have been unpopular because they were rough and noisy, and as they became more rough they naturally became more noisy. One phase of the question then was to make the pavement smoother.

Sherrerd Pioneered for Improved Granite Pavements

The one man to whom the most credit should be given for starting a movement for a better granite pavement is without doubt Mr. M. R. Sherrerd, Chief Engineer of the Department of Public Works, Newark, N. J. At his suggestion a meeting was called in New York City in 1909 composed of many highway engineers in the East and the manufacturers who produced the granite blocks used in that section.

The idea was not simply to specify a block that would make a good pavement. That would have been comparatively easy. But what was desired was to decribe such a block and have it also one that *could* and *would be* furnished at a reasonable price.

Advantages of Standard Sizes

Another thought was that if the engineers of New York, Philadelphia, Boston and Newark could all agree upon a standard specification so that the same blocks could be used in any of these cities the problem would be much simpler for the manufacturer and the result just as good if not better for the cities themselves. At that time no two of the above-mentioned cities were using blocks of the same size. So that when a hurry-up call came from any one city for an extra amount of blocks, it often could not be supplied, although the manufacturer might have plenty of blocks that he could not dispose of on account of the size. The possibility of the interchange of blocks between the different cities is of great value. Then, too, it is much better for the block cutters themselves to know that they are making one style of blocks all the time. It adds greatly to their efficiency and consequently to their wages, as they always work by the piece.

This New York meeting was quite fully attended and very harmonious. The manufacturers recognized that if a better granite pavement was produced it would very much increase its popularity, which had been on the wane since the introduction of asphalt and other smooth pavements. The manufacturers brought out the point, which had not been fully appreciated by the engineers, that if the blocks were made smaller, that is no larger than the demands of traffic required, they could be made smoother much more easily and with less labor. It is a fact also that the smaller the individual unit in any mass, the smoother will be the resulting mass. To show this by extremes one need only compare a surface composed of irregular sized cobble stones with one of fine sand. But in a pavement the minimum size that will satisfy traffic should be permitted.

VIEW OF NEW GRANITE BLOCK PAVEMENT ON BEDFORD AVE., BROOKLYN, SOUTH FROM ST. JOHNS PLACE

The result of the meeting was highly satisfactory as it not only brought the producer and the consumer more closely in touch with each other, but it did unquestionably have a great influence in the character of granite pavements, which throughout the country have been much improved since that time.

As has been intimated the introduction of the improved granite pavements has been retarded by the extra cost even if that were not very great. Engineers as a rule do not have much to do with the appropriation of funds for street improvements except to recommend it. It took some time for city authorities to realize that the new pavement was worth its extra cost and that while at first it seemed more expensive it was really more economical in the long run on account of its greater durability. Practically all cities can afford to, and all should, build any structure with a view to its ultimate rather

than its first cost. This is especially true of a street pavement, which is constantly being used by the public to whom its constant tearing up for repair or renewal is a great nuisance.

Considerations Affecting Design

The possibility of variation in the specifications to meet requirements being recognized a study of these requirements becomes necessary. Before an architect plans a building he first makes himself conversant with the uses to which it is to be put. So, too, must the engineer study the requirements of a street to be paved. Once having determined upon granite as a material he must next decide as to just how this material is to be used. To do this intelligently he must know the amount and nature of the traffic the pavement will be called upon to sustain, understanding that a thousand units of 1 ton each will produce a different result than a hundred units of 10 tons each. Then, too, he must know whether the traffic will be steel or rubber tired, for if a tire of soft material be used so that the load produces a certain pressure rather than an attritive wear so that it might be necessary to provide an extra strong foundation rather than extra wearing block. As has been said before very few granite blocks actually wear down to a great extent and, therefore, a particularly hard block is not always required. They also are very seldom actually crushed by traffic. There are very few granites, if any, that will not stand present truck loads. A block that will wear down smoothly and evenly is very desirable and should be used, if easily obtainable, except on steel-tired, heavy traffic streets.

After the character of the granite itself, the items most to be considered and upon which engineering practice differs most at the present time are, dimensions of the blocks, how closely the blocks should be laid, character of the joint filling and whether the blocks shall be bedded in sand or in a mixture of sand and cement. It is understood that a base consisting of Portland cement concrete sufficiently strong to sustain the loads will be provided.

Present Standard Blocks

The size of blocks in the standard specifications for granite at the present time are: Length, 8 to 12 ins.; width, 3½ to 4½ ins., and depth, 4¾ to 5¼ ins. This is practically what was determined upon at the New York conference. The most important dimension is the depth, although width must be considered, especially if the pavement is to be laid upon an appreciable grade. A narrow block gives better foothold to horses and probably looks better, but it is doubtful if in any event the width should be less than 3 ins. and then only in exceptional cases. Whatever the width, it would be desirable to have all blocks the same, but that would entail considerable, and from a utility standpoint extra, expense. For that reason the 1-in. leeway is given in the width. The blocks, however, should be so sorted that those of equal size should be laid together.

The depth is important both because it must take care of whatever wear there is and because an unnecessary depth makes the cost more on account of freight charges. A lightweight block is also more easily and quickly handled by the paver.

In length a too short block makes many joints parallel to traffic, which is liable to undue wear no matter what the filler. One that is too long is liable to move under the wheel loads unless solidly bedded. A length of 8 or 9 ins. would probably be ideal, but the question of expense again comes up if the restriction is made too strong. A length of 8 to 12 ins. is generally satifactory.

Joint Width

How closely the blocks shall be laid or what the width of the joints shall be depends upon how well the blocks are made and the specifications generally state that they shall be so dressed as to lay with a certain joint width in the pavement. The old requirement when tar and gravel joints were used was for a ¾-in. joint, while now one of ⅜-in. is often called for. This difference of ⅜-in. calls for a much better block and produces a correspondingly better pavement.

Joint Filler

When granite blocks were first laid the joints were filled with sand, but when a concrete base was used gravel took the place of sand with coal tar poured into the voids of the gravel so as to make a water-tight joint. Later a grout made of equal parts of cement and sand was used, Worcester, Mass., probably being the first city to adopt this method. When the new blocks were adopted a bituminous filler was tried with good results and later still a mixture of sand and coal tar or asphalt.

While the intent of the tar and gravel filler was to produce a joint impervious to water, such a condition was not always obtained. The ¾-in. joint allowed the use of large sized gravel, making large interstices, which required great care to fill. If the gravel was reduced in size the interstices were liable to be so small that unless the filler was always hot the voids were not filled. This joint filling cost from 35 to 40cts. per yd. and the writer never felt that good value was received for the money.

The cement grout joint is satisfactory, where carefully made, as far as use is concerned, but when the pavement is taken up for any subsurface work many of the blocks are broken and after the restoration great care must be taken to keep traffic from it till the grout has had full time to set. In new work this same precaution must be taken, so that the opening of the street for use must be delayed for a considerable length of time after the pavement is finished. On the other hand the cement filler makes a continuous and complete surface and fills all the irregularities of the blocks. With blocks dressed for a ⅜-in. joint it is possible to use a pitch filler satisfactorily. With a large joint too much pitch would be required both from a financial and use standpoint. When a quiet pavement is desired pitch is most satisfactory as it prevents the noise from the wheel concussions being transmitted from block to block, thus making a continuous roar. Since, however, the adoption, to so great an extent, of auto trucks with their rubber tires this is not so important.

Some engineers use a mixture of equal parts of sand and pitch for two reasons: One to reduce the expense and the other to make the pitch more stable; that is, to have it change less with the changes of temperature. It undoubtedly accomplishes both. Mr. John Brodie, City Engineer of Liverpool, was probably the first engineer to use this combination in the application of bituminous material to broken stone surfaces.

Cushion

The first specifications for granite blocks on concrete called for a sand cushion. And as the blocks varied an inch in depth, in order to give them all a firm bed this cushion had to be 2 ins. thick, but when the new blocks were adopted it was possible to reduce this to 1 in. and sometimes less when the concrete was very smooth. As the only use of the cushion was to insure an even bearing to all blocks it was desirable to use simply what was necessary. More recently it has been the practice of some engineers to lay the blocks in a cushion of cement and sand, so that when this mixture had set the blocks would be absolutely solid with no possibility of any displacement by the movement of the cushion, which sometimes occurs when sand alone is used. The objection is that the entire pavement including the base is one monolithic structure, hard and solid with absolutely no resilience. The people favoring this practice do not think this objection is important, and in any event is more than compensated for in the increased durability of the pavement. If a cement joint filler is used the objection to the mortar bed can hardly be objected

to. With this bed great care must be exercised to have each block set firmly, solidly and evenly, so that the cement set may not afterward be disturbed.

The Bedford Ave. (Brooklyn) Granite Pavement

One of the best examples which the writer knows of where special care has been exercised in designing a pavement is the one now laid on Bedford avenue, Brooklyn, between Sterling Place and Eastern Parkway. This avenue is the great north and south street of the borough. It sustains a very heavy traffic of automobiles and auto trucks, practically all with rubber tires. It has a grade so steep that it was not deemed advisable to pave it with asphalt, but a smooth pavement was desired. It was paved in 1916 with special granite blocks set on a mortar bed with cement grout joint. It has passed through two severe winters and the only cracks are small ones across the roadway at fairly regular intervals, probably due to contraction, marring slightly the appearance, but not at all interfering with the use of the pavement. The surface is exceedingly smooth, and as the writer had nothing to do with either its design or construction, he has no hesitation

OLD GRANITE BLOCKS, READY FOR REDRESSING, REMOVED FROM THIRD AVENUE, RECUT AND RELAID ACROSS CENTRAL PARK, NEW YORK CITY.

in saying that no better pavement for its use can be found anywhere. This pavement cost on a 6-in. concrete base, with no maintenance, but including the removal of the old pavement, $4.30 per sq. yd. Quotations are herewith given from the specifications that show the particular points emphasized in the construction.

The cost of repairs to the improved granite in Brooklyn as compared with the old is as follows:

	*No. Yards Maintained	New Method	Old Method
1914.....	266,664	Total, $43.95	$0.011 per yd.
1915.....	417,502	0.004 per yd.	0.024 per yd.
1916.....	536,067	0.007 per yd.	0.03 per yd.

*Figures only refer to yardage of improved pavement.

It must be understood, however, that the old method streets were first paved in 1895, while the first improved pavement was laid in 1910. So that there was 15 years' difference in the age of the pavements.

Extracts from Specifications for Granite Block Pavement on Bedford Ave., Brooklyn

On the subgrade thus prepared shall be laid the concrete foundation 6 ins. thick, consisting of 1 part of Portland cement, 3 parts of sand and 5 parts of broken stone or gravel.

The granite paving blocks shall be of fine grained granite showing an even distribution of constituent minerals, of uniform quality and texture, without seams, scales or disintegration, free from an excess of mica or feldspar and equal in every respect to the samples in the office of the chief engineer. The granite shall have a toughness of not less than 9 and a French co-efficient of wear of not less than 11, as determined by method employed at the United States Department of Agriculture, Office of Public Roads.

Blocks shall be of the following dimensions, viz.: Not less than 7 nor more than 11 ins. long on top, not less than 3¾ nor more than 4¼ ins. wide on top, not less than 3¾ nor more than 4¼ ins. deep.

The blocks shall be cut so that the faces will be rectangular in shape and the ends and sides sufficiently smooth to permit the blocks to be laid with joints not exceeding ⅜ in. in width at the top and for 1 in. downward therefrom and not exceeding ¾ in. in width at any other part of the joint. The top surface of the block shall be cut so that there will be no depressions measuring more than ¼ in. from a straight edge laid in any direction on the top and parallel to the general surface thereof. The blocks will be measured and all blocks not conforming exactly with this specification will be rejected.

On the concrete foundation hereinbefore described shall be laid a bed of clean, coarse, dry sand mixed with cement and averaging ¾ in. in depth so as to bring the surface of the pavement, when thoroughly rammed, to the proper grade. The sand shall all pass a ¼-in. mesh screen and shall be thoroughly mixed with the cement in the proportion of 1 part of cement to 4 parts of sand. Upon this bed the blocks shall be laid at right angles to the line of the street, and in a straight line from curb to curb, except in special cases when they shall be laid at such an angle as may be directed by the engineer, who is also to determine the grade and crown to which the blocks must conform. Each course shall be of uniform width, and so laid that all longitudinal joints shall be broken by a lap of at least 3 ins. The stone blocks shall not be laid more than 25 ft. in advance of the ramming. No blocks or other material must be thrown or deposited in such a manner as to displace the blocks on the face of the work, and no carting will be permitted over the surface of any unfinished portion of the pavement.

Immediately after the blocks are laid they shall be thoroughly rammed and brought to an even and true surface.

After the pavement has been brought to a uniform surface it shall be sprinkled with clean water and Portland cement grout shall be poured into the joints until it appears on the surface. The grout shall be broomed into the joints if necessary to fill the same, and the operation shall be continued as the grout settles, until the joints are thoroughly filled flush with the surface of the blocks.

The cement grout shall be composed of 1 part of Portland cement and 1 part of clean, sharp sand passing an 8-mesh per inch screen. The cement and sand shall be thoroughly mixed dry and sufficient clean, fresh water shall be added to give the grout proper consistency.

The grout shall be mixed in a machine mixer, approved by the engineer. The character of the mixer shall be such that the mixing of the grout shall be continued until the instant that it is poured into the joints.

The work of filling shall be carried forward until an advance area of 15 or 20 yds. has been grouted, when the same force and appliances shall be used to regrout the same space in a like manner.

The work shall be kept lightly sprinkled with water ahead of the sweepers, to avoid a possibility of causing the grouting to become too thick at any point. To insure the penetration of the grout into the joints of the pavement a squeegee scraper 15 to 18 ins. in length in addition to the broom shall be used upon the last application of the grout.

After the grout between the joints has fully subsided and

the initial set is taking place, the whole surface shall be lightly sprinkled with water and the surplus grout left on the top shall be swept off. After the grouting is completed and a sufficient time for hardening has elapsed, so that a coating of sand will not absorb moisture from the cement mixture, ½ in. of sand shall be spread over the whole surface.

After the grouting is completed the street shall be kept closed and no carting or traffic allowed on any part of the grouted pavement until at least 10 days have elapsed. The surface of the pavement shall be kept moist, as may be directed by the engineer.

Recut Granite Blocks

The most radical change in granite pavement construction during the last few years has been the use of recut blocks. The old large blocks that were previously discarded entirely when a new pavement was laid have in many instances been recut into blocks of different dimensions and used to good effect. The very large size of the old blocks has made this possible. In some cases it is stated that the recut blocks

RECUT GRANITE BLOCKS LAID ACROSS CENTRAL PARK, NEW YORK CITY, READY FOR JOINT GROUTING.

laid a larger area of pavement than the old ones. As has been stated heretofore many pavements have been replaced not because the old blocks had been worn out, but worn in such a way as to be too rough to be serviceable. A block, for instance, originally 4x8x12 ins. that had become somewhat turtlebacked under traffic could be cut perpendicularly to its original surface so as to make three good blocks 4 ins. deep each with a wearing surface of 32 sq. ins. or 96 sq. ins. in all, while it originally had a surface of 48 sq. ins. only. These blocks, of course, would not be recommended for heavy traffic streets, but in certain cases where for grade or other reasons a stone pavement was desired, if laid in a mortar bed with a cement grout filler, they would give entire satisfaction. Strangely enough, the idea of recutting blocks was first presented to the writer by a producer of granite blocks himself, one who would naturally be interested in selling new blocks, but he really wished to see the old material used to its full advantage. As this proposal was made some years before any work of this kind was done it seems altogether likely that he was its originator.

The New Central Park Pavement

A pavement of this character was recently laid on the roads running across Central Park, New York City. The old blocks were taken from Third avenue, which was being repaved, and were originally 3½ to 4½ ins. wide, 7 to 8 ins. deep and from 9 to 12 ins. long. The specifications required the new blocks to be 3½ to 4½ ins. wide, 4¾ to 5½ ins. deep and 6 to 10 ins. long. This did not allow as radical a saving as the example previously given on account of the size of the recut block. The old blocks had been in use 24 years and with the old practice would have been thrown away or used for some minor purpose. The recut blocks were laid with a mortar bed and a cement grout joint. The pavement cost $2.15 per sq. yd., a saving of $2 or more per yard.

If the old blocks can be cut and used on the same street the maximum amount of saving will be had.

Construction Plant and Methods Employed in Building Reinforced Concrete Roads at Camp Custer, Battle Creek, Mich.

By George A. Burley, of R. D. Baker Co., Penobscot Bldg., Detroit, Mich.

I do not believe that permanent pavements were embodied in the original plans for Camp Custer, the National Army cantonment near Battle Creek, Mich., inasmuch as no contract was let for their construction until long after the building, sewer and water works contractors had been on the ground. However, from the nature of the soil, which is very sandy, it soon became evident to the engineers that gravel or macadam roads would not stand up under the heavy army truck and mule team traffic necessary to carry supplies to the various parts of the camp. They then decided on concrete for the main roads and gravel roads between the barracks.

On the 19th of July, 1917, we arrived on the grounds without any equipment, as the siding from the M. C. R. R. was not yet halfway up to the camp and the roads were bad for drawing in any heavy machinery. The following day we had about 20 teams with Western wheel and slip scrapers at work grading and a large number of men cutting and grubbing out about 1¼ acres of trees at the eastern end of the camp. We had no grade stakes to begin with, only a general line being given, and had we known that such large cuts and fills would be encountered we would have shipped in a steam shovel as it would have greatly facilitated the work. The first fill made was about 13 ft. deep and so steep were the sides of the hill that it was necessary to drag the wheel scrapers down without raising them in order to avoid running onto the teams.

All stumps that were not covered by at least 2 ft. of earth were grubbed out and those that were left in, regardless of the depth of fill, were cut off flush with the ground. The trees were trimmed up, the brush burned and the timber hauled into piles to be used for various construction purposes about the camp.

The specifications called for rolling all fills in 9-in. layers with a 10-ton roller. It was, however, found impossible to get a 10-ton roller down into the bottom of the fills and to operate it successfully in the red sand. It continually stalled and required jacking out. We then abandoned rolling with a 10-ton roller and obtained two 1½-ton Beach corrugated rollers, which gave the best of satisfaction, and I am of the opinion that in rolling soft material they are superior to a heavy machine. The first time over they go down quite deeply and seem to pack the fill from the bottom up. When the fill was brought to grade and all rolled with 10-ton rollers of the Buffalo-Pitts type, we found that the fill held the rollers up better than the original ground in the cut. These rollers required two teams each for their operation if employed continously. All sods were removed unless covered by a fill of at least 2 ft.

About ½ mile of rough grading was completed before the railroad siding was in and then we unloaded a Thew 1-yd. clamshell for unloading material from the cars, a No. 11 Koehring mixer, 1½ cu. yd. industrial cars and track for delivering material to the grade. As the soil was so light, we anticipated trouble in keeping up the track if a locomotive was used and so did not ship one in, but handled the cars with teams. As

the first part of the work was up hill and down, we kept teams at the foot of the hills to haul the trains of 4 to 6 cars up and men operating the brakes would ride them down. With this method of handling material we could put from 8 to 10 carloads on the grade per day. Where possible we laid a double line of track and dumped in toward the center. The double tracks permitted operating without switches.

Our greatest difficulty was in the congestion at the sidings. Cars were continually running over the industrial track and the heavy trucks and teams hauling lumber would knock the tracks out of line and sometimes stall so as to tie up the cars or derail them. Yet, we believe, this was the most ecenomical way of handling the material, as the grade would have been cut up badly if we had undertaken to haul the material in wagons. Trucks would have been out of the question as in hauling lumber and other supplies for the buildings it was necessary to put brush, hay and even ensilage on the roads to get those trucks through the sand. Even with this method it was almost impossible to maintain a finished grade ready for the concrete for any distance ahead of the mixer. We finally resorted to fencing to keep traffic off the grade and a force of men was continually employed driving 2x4-in. stakes with a single 2x4-in. rail on top. Besides this cross fences were put up, for should drivers break through with trucks they would run straight down the finished grade.

Material used for the concrete was washed sand and gravel from Kalamazoo. This material was fairly clean, with the exception of times when it rained, when the top soil was not stripped off, the clay would wash down into the gravel to a greater extent than the washing plant could remove it. A number of cars of gravel were rejected for concrete and were used for shoulders. No check on this material coming in was kept, as we took the total output of the pit and then occasionally were held up through lack of sand and gravel. The cement was purchased from three nearby cement plants, Peerless, Wolverine and Burt, and the delivery was very good, but trouble was experienced because other contractors unloaded our cars, and at times we were completely out of cement due to this confusion.

The mixture of the concrete was about 1 of cement, 1½ sand and 3 parts gravel. I say "about" because the sand not being graded from fine to ¼ in., a shovelful of cement was put into the hopper from a wheelbarrow. After the concrete was finished small depressions would occur in places between the coarser aggregates, due to the settlement of the neat cement, also small pores would appear. The engineer's attention was called to this and he ordered additional cement added to make up for the lack of grading in the sand. This was an aid, no doubt, but as neat cement is not as hard as particles of sand it did not produce a wearing surface capable of resisting wear as well as a graded sand.

Baker steel side forms were used except on very short curves, where they were replaced by 2x6-in. plank, which could be bent to the required radius. To insure against settlement of the forms, they were set on 2x2-in. hubs driven with their tops 6 ins. below grade.

The main road, which was 18 ft. wide, 6 ins. deep at the edge and 8 ins. at the center, was reinforced with American Steel and Wire mesh and Kahn reinforcement. The reinforcement was cut in 14-ft. strips and placed staggered in the concrete. The first strip of reinforcement was laid 1 ft. from the edge and extended to within 3 ft. of the other edge. The next strip was placed 3 ft. from the corresponding edge and extended 1 ft. from the other and so on. This I believe to be the best method of reinforcing as it uses a minimum of steel and at the same time places the heaviest reinforcement where it is needed at the center. Joints were placed every 30 ft. using a ½-in. Elastite filler and the reinforcement extended clear to the joint. The filler was 9 ins. wide and the joint was finished with a split float. After the concrete was set the felt was cut off flush with the surface. As we had no finishing machine ready to place on this work, the surface was finished by passing two belts over it, a narrow and a wide one, and the edge of the concrete was slightly rounded along the form.

During the hot weather the concrete was covered with about 2 ins. of earth and kept watered for seven days. The cover was left on until time to open up the road. Great difficulty was experienced in keeping traffic off until the concrete was properly cured. Six carpenters with helpers were continually putting up barricades and fences and yet teams or trucks would occasionally cross it. In some cases so great was the demand for its use that the road was opened up sooner than we desired. Often crossings were put over the green concrete the next morning after laying to allow for hauling material from various sidings. These were made by spreading on a thin layer of earth and then covering with a double course of 2-in. plank. No bad results were noted from such crossings over the green concrete.

For the greater part of the construction the water was obtained from creeks and lakes and pumped through a 2-in. pipe line with New Way gasoline engine driven Fairbanks-Morse pumps. So great was the distance and elevation to be pumped from one lake that where two mixers were used it was necessary to put a booster station in the line. This was so arranged that should the first pump fail to deliver sufficient water it would pump into a tank halfway and the second pump would take it from there and force it on. Most of the pipe line had to be covered by plowing a furrow and dropping it in, as motor trucks and teams were continually crossing in every direction. We were also troubled by the trenching machines that were putting in sewers cutting through our water pipe. It required us to have continually in readiness a team carrying fittings, tools, pipe vise, etc., with two men to keep the pipe line in repair.

As the work first anticipated did not greatly exceed 3 miles, only one mixer was placed on the job, but after it was decided by the government engineer to double this amount we hurried another No. 11 Koehring mixer to the camp and put it to work. Twelve turns of the mixer was specified for each batch, yet we were able to put in as high as 360 lineal ft. per day of 18-ft. road, and with one mixer we placed 9,000 ft. in 30 days.

The warehouse section was the most difficult to construct as we had to arrange our work so as to make it possible for army trucks to obtain supplies. This necessitated our shifting up and down between the warehouses, putting in pieces here and there. The warehouse pavement was about 1,600 ft. long and about 60 ft. wide between buildings and 6 ins. thick, all of which was reinforced. This pavement was placed on a fill of 2 to 3 ft., and was flat with a slope in one direction.

The difficulty was not in obtaining labor for this work, but to get work out of the labor. All classes of labor were employed, even to Mexicans, and during the early part of the work nearly 50% of the entire force either quit or was discharged each week. This necessitated our employing a man to obtain labor and it was his duty to bring a truck load out to the camp each morning. The labor was paid 35, 37½ and 40 cts. per hour for 8 hours and time and one-half for overtime, making 11 hrs. pay for 10 hrs. work. The variation in the price depended on the class of work done. The crews at the mixers were almost entirely negroes and proved the most satisfactory class of labor we had. The employes were housed in tents, farmhouses that were abandoned by their owners, and even garages and granaries were fitted up with army cots and blankets to take care of them. In the early part of the work they were kept in government barracks, but when the drafted men began to arrive, being continually moved from one building to another, the laborers became dissatisfied and so we ar-

ranged to take care of them in other places. All workmen were fed at the commissary, if they desired, by purchasing tickets at 35 cts. per meal or 3 meals for $1. These were charged to their account and a constant check had to be kept on this as the men gambled in meal tickets and many would overdraw their account if possible.

There were employed as high as 92 teams on this work, grading, hauling cement and material for the concrete road and hauling gravel from a local pit for the gravel roads. These were all taken care of in four barns, two of which were government built and the other two remodeled barns vacated by farmers forced to move from the reservation. Each barn was in charge of a "barn boss," whose duty it was to see that

VIEWS OF REINFORCED CONCRETE ROAD BUILT AT CAMP CUSTER, BATTLE CREEK, MICH.

Upper: Main Road Back of Barracks, Practically Only Level Stretch. Middle: Between Barracks Buildings, 60 Ft. Wide on 2 to 3 Ft. Fill. Fill on Curve; Only Place Where Unloading Track was Near Road.

all teams in his barn were properly cared for and that all went to work on time supplied with the equipment necessary for that job. They also reported any teams "standing in" through lack of teamsters so that our employment man could supply new ones each morning or pick out some teamsters from among the laborers. It was also their duty to advise the office as to their requirements for hay and grain. Baled hay and oats in bags were purchased in carloads. By order of the sanitary department all litter had to be removed from the barns each day and, as this had to be hauled about 3 miles, one team was detailed from each barn for this work. To take care of horseshoeing and general repairing a fully equipped blacksmith shop was built and two blacksmiths employed. Teams were paid at the government schedule of 30 cts. per hour, time and one-half for overtime and 10 cts. per hour being taken out for feeding. This made a charge of $1.10 per day for feed, which we found at the price of hay and grain barely covered the cost. All teamsters were hired by us and received 35 cts. per hour. Where dump wagons were used the team owner received 50 cts. per day rental. The greatest number of men employed on this work was about 280. This large force was required in order to carry on the gravel road construction along with the concrete.

All laborers were given brass number checks and one timekeeper covered the whole job. In the first part of the work the men checked in at stiles morning and afternoon and out at noon and night. The timekeeper also checked them on the job in the forenoon and afternoon. The checking of numbers at the stiles consumed too much time and was of little value because of the large number employed, so was abandoned later when each foreman was given a time book and checked the men in and out, turning the book over to the time keeper. The week ended on Saturday night and pay day was Wednesday. Payment was made by check, which made considerable office work.

Ditches were built on each side of the road to drain to the natural water courses with cross culverts of Armco corrugated pipe placed at close intervals for cross drainage. Adequate disposal of storm water was not provided in many cases because camp buildings were built without regard to natural water courses. The shoulders were carried out with 6 ins. of gravel 2 ft. from the concrete on each side and throughly rolled, and the roadway made 24 ft. over all. This gravel was obtained from a local pit and clammed into Studebaker dump wagons.

"Sacrifice economy for speed," was the order from the constructing quartermaster. Yet this did not in any way overcome the difficulties in connection with the work. In order to facilitate the construction of the hospital itself we placed a large grading force on the railroad with the understanding that the railroad was to be torn out and the heavy grade used for pavement. With only 3 days' notice we were told that the railroad would remain and we must grade through to the hospital alongside the railroad. Conditions like this made it difficult to plan the work ahead in order to keep two mixers going continually, but we did this from the time we started until the job was finished.

The railway sidings were very badly congested with building material, tile, water works pipe, etc., and although the mixer was working within a few hundred feet of a siding it was sometimes necessary to haul the cement a mile. Switching service was very unsatisfactory. Often the unloading gangs were laid off with material in the city yards that could not be brought to the camp in time.

Considering the difficulties encountered we believe good time was made, as from the 20th of July until we began loading equipment on the 29th of November, 60,360 yds. of concrete were placed and about 8 miles of gravel road built and 3,000 ft. of 12-in. crock laid. Five hundred feet of this concrete was laid on an old road bed and the balance all passed through woods and farming country, with big cuts and fills and many curves. At one point the concrete is laid over a fill of 30 ft., which was made with a steam shovel and cars. It will be interesting to note what settlement takes place at this point. The actual mixing time in placing this concrete, which is equivalent to building approximately 6 miles of 18-ft. road, was 3 months and 10 days.

No accurate costs on the road work can be given. This is due to the extra work done, such as railroad grading and digging the basement for the laundry, for which no separate cost account was desired by the government. And as this work took in so many conditions that are not met with in the ordinary road building we did not consider a cost record of any value to us.

Destruction of Wood Block Pavement Due to Use of Tar in the Creosote Oil

By P. C. Reilly, Republic Creosoting Co., Indianapolis, Ind.

The serious results that follow the use of wood paving blocks, which have been treated with creosote oil mixed with tar, are well known to almost every paving engineer, chemist and contractor. The history of the pavement laid in 1909 on Washington Boulevard, Indianapolis, can be duplicated in many parts of the country.

Extreme Bleeding

The blocks were treated with 20 lbs. of a tar-and-oil mixture to the cubic foot. For the first three years the street was not usable during the summer months, as the tar exuded from the blocks in such volume as literally to flood the street. Automobiles were forced to detour and the property owners were obliged to lay planks at the crossings to avoid spoiling their shoes, carpets and floors with tar.

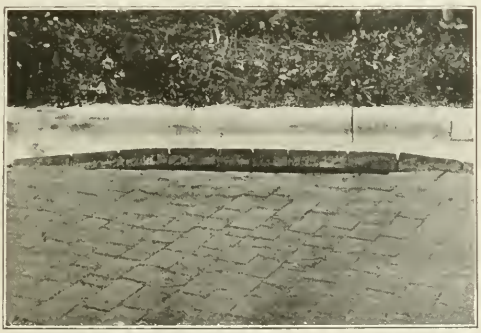
The street was not usable because of this bleeding during the summers of 1910, 1911 and 1912. For the three years following this bleeding period it was seemingly in fairly good condition, bleeding and buckling somewhat, but neither to a harmful degree.

Tar Bled Out, Leaving Fibers Exposed

From the events which followed it seems safe to assume that practically all of the tar had reached the surface and either exuded or formed a surface coating, which was gradually being worn off by traffic, for by the end of the second three years the surface coating of tar had lost its efficacy, the elements had removed the volatile portions of the creosote oil, which are always present in such mixtures, and the wood fibers were left without protection.

As a result, beginning with the fall of 1917, bulging from the entrance of water became so bad that the pavement has become very dangerous to traffic, as shown in the accompanying photographs.

Chronologically, therefore, the history of the pavement is this: For the first three years it was not usable and a nuisance because of the bleeding of the tar from the blocks.



VIEW SHOWING EXPANSION AT CURB LINE OF TAR-AND-OIL TREATED WOOD BLOCK PAVEMENT ON MERIDIAN STREET, INDIANAPOLIS.

For the next three years the street was usable, but showing signs of rapid deterioration, at a time when a properly treated block pavement would hardly show signs of service.

Bulging

The bulging period then set in, and it will be a constant source of danger and expense on this street, for it cannot be remedied and will continue to grow worse. It may be retarded temporarily by coating the surface with pitch or some similar surfacing material, but the relief will be temporary, at best, because the pitch cannot penetrate to the interior of the blocks, and the water will enter through every break in the surface.

This tar-and-oil mixture has been widely used in past years, and almost always with results similar to those here set forth. It is not a creosote oil in any sense; it does not make a creosoted paving block, and pavements of such blocks should not be confused with the genuine creosoted wood block pavements, which are entirely free from such troubles if properly treated.

Defects of Tar-and-Oil Treated Wood Pavements

The reason for the wholesale failure of tar-and-oil treated wood block pavements, and for their rapid decline in popular favor, is immediately apparent to engineers and chemists, for it is impossible to secure permanency from a mixture which contains both volatile elements and substances which are constantly changing in their chemical composition. Such materials are not stable and stable results cannot be obtained from their use.

Engineers and chemists know, too, that if materials incorporated in a pavement subsequently exude or evaporate from

VIEWS SHOWING BULGING OF TAR-AND-OIL TREATED BLOCK PAVEMENTS, INDIANAPOLIS, IND.

Upper—Washington Boulevard Pavement, February 12, 1918. Laid in 1909. Between Thirty-fourth and Thirty-sixth Streets. Middle—Another View of Same Pavement. Lower—Expansion in Pavement Shown Occurred in One Day. Pavement Fifteen Years Old.

that pavement, there will be left voids in the pavement which will quickly be occupied by water, air and other agencies of destruction. This is exactly what happens where pavements are treated with any tar-and-oil mixture.

It is well known that a creosote oil of the proper quality will produce a stable pavement—one that is permanently resistant to the effects of moisture and which therefore will not

bulge. Nor can it bleed tar, as there is no tar in its composition.

Such an oil should be absolutely pure; it should have a specific gravity of not less than 1.12 at 25 deg. C., and it should respond to the well-known tests for determining quality and purity.

An oil of this kind penetrates the most minute cells of the block and becomes fixed therein—a constant barrier to the entrance of harmful agencies which attack unprotected blocks. To insure securing such an oil, specifications should be most carefully drawn, with great attention to detail.

It is unfortunate, in one sense, that this Washington Boulevard pavement gave fairly good service during the intermediate period, for during this period it might have been considered a good representative pavement. Its inherent defects were not visible to the casual observer, while if the pavement had been continuously bad from the beginning it would not have been nearly so harmful to the prestige of the true creosoted wood block pavement.

Chemists and engineers are expected to guard the interests of their communities against obvious mistakes, and it is a mistake to use a creosote oil which has been adulterated with tar or which contains volatile elements that are subject to evaporation or dissolving when exposed to the elements.

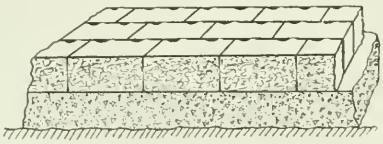
Some Design and Constructional Features of Modern Brick Pavements

By F. A. Churchill, Conneaut, Ohio

Modern brick pavements are of two general types: monolithic and composite. A monolithic brick pavement, as the name signifies, consists of a single rigid beam. Depth of beam is beside the point. The monolith may be a single course of grouted brick laid on natural soil, or it may comprise two or three strata of different materials united in a solid beam unit.

Pavements Without Artificial Foundations

In many sections of the South, where frost action is negligible, and in several Northern cities as well, the monolithic beam is formed of a grouted brick surfacing only, the brick being laid on compacted natural soil. Where the soil compacts firmly and frost action is not troublesome, this type of construction can be relied upon to give satisfaction, with ordinary heavy traffic. Even in some Northern cities, in which the soil



WIRE-CUT LUG BRICK--GREEN CONCRETE FOUNDATION
CEMENT OR BITUMINOUS FILLER

is gravelly or sandy, pavements laid without artificial foundations have given acceptable service for many years. Cleveland, Ohio, has more than 30 miles of such pavement, and continues to lay some of it each year on natural soil foundation.

The Cement-Sand Bed

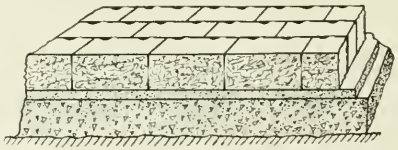
In many sections, especially in the Southern states, where frost upheavals are rare, the use of a 1-in. cement-sand bed under the brick, and the use of a 3½-in. brick, is becoming the prevailing type of construction. No longitudinal cracks appear in brick pavements in the South.

This type of construction has been used to some extent on state highways in Illinois, and on the Lincoln Highway in Indiana, and experience has demonstrated its value in resurfacing macadam roads with brick.

The 1 in. of cement-sand bed spread over compacted natural soil or macadam serves as a bedding course for the brick; it prevents the soil from working up into the joints when the brick are rolled, and, after it sets up, it protects the pavement against water which may invade the sub-grade. Unlike a sand cushion, the cement-sand bed does not shift or settle in spots.

Concrete Foundation

In sections where severe winters are the rule, or where heavy trucking, in the modern sense, may be expected, a monolithic pavement usually is constructed with a concrete foun-



WIRE-CUT LUG BRICK--CEMENT-SAND & CONCRETE FOUNDATION
CEMENT OR BITUMINOUS FILLER

dation either 4 or 6 ins. in depth. Generally speaking, a 4-in. brick is used for surfacing, but excellent results have been obtained with a 3½ or a 3-in. brick of a type affording exceptional bonding strength. Three-inch and even 2-in. concrete foundations have proven entirely satisfactory in some sections, notably in the South and in Illinois.

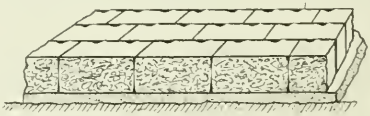
Local conditions of soil, climate and traffic should determine the depth of foundation specified.

Two Methods of Constructing Monolithic Brick Pavements

There are two methods of constructing monolithic brick pavements, although for convenience in distinguishing the methods, rather than as a means of differentiating types of pavement, these methods are often misleadingly referred to respectively as monolithic and semi-monolithic, or as green-concrete and cement-sand bed construction.

The two methods achieve practically the same result. With the first method the brick are laid on a green concrete foundation—if any foundation is used—either with or without a ¼-in. film of cement-sand spread over the green concrete, in order to compensate the slight inequalities of surface which sometimes occur, unless extreme care is exercised in preparing the surface of the base.

With the second method a cement-sand mortar bed, usually in proportions of 1 to 4, thoroughly mixed in a mechanical mixer, is spread dry, not to exceed 1 in. in depth, over a cured



WIRE-CUT LUG BRICK--CEMENT-SAND FOUNDATION
CEMENT FILLER

concrete foundation, and the brick are laid on this bed and are grouted.

Theoretically, the cement-sand bed is converted into a mortar by wetting down the brick just before the grouting is done. The mortar bed effects a practicable union between the brick surfacing and the concrete foundation, and it assures an even bearing for the brick and a stable beam.

Either method necessitates shaping the surface of the concrete foundation as nearly as possible to a true contour and cross-section of the proposed surface of the finished pavement, and at the correct depth below the designed surface. In every case in which the cement-sand bed is used it is regarded as 1 in. of the foundation; that is to say, if a 4-in. foundation is designed, 1 in. of the 4 ins. is cement-sand bed. No cross-expansion joints are used on monolithic pavements, but on city streets where curbs are used, longitudinal expansion

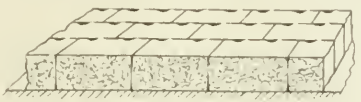
joints are placed alongside the curb to the depth of the foundation.

Green concrete construction was originally designed for highways especially, although it is adapted to streets as well. Cement-sand bed construction is more easily handled on wide streets, since a cured foundation is used; but it is fully as serviceable on highways and it is frequently so used.

Neither method requires flush side-edgings on highways. Earth or gravel shoulders give ample protection to the edges of the pavement.

Composite Pavements

Composite brick pavements are those in which unusual combinations of materials are used. Of these are brick pavements



WIRE-CUT LUG BRICK--NATURAL SOIL FOUNDATION

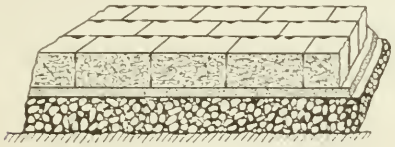
CEMENT- FILLER

with bituminous filler and bituminous-bound foundation, or with bituminous-bound foundation, cement-sand bed and cement-grout filler.

A wire-cut lug brick pavement may be laid with the lugs down in green concrete and the rough, wire-cut side uppermost. Over this roughened surface a carpet of some bituminous preparation may be spread.

Vertical Fibre Method

This method of construction is known as the vertical fibre method, because traffic passes over what is theoretically assumed to be the ends of the structural strata of the brick instead of the strata running theoretically horizontal to the plane of traffic. Of course, no good paving brick has a pronounced stratified interior structure, and no brick has a fibrous formation. Shale or clay is ground fine, it is mixed thoroughly and the constituent particles are closely compacted, practically uniformly, by the augur machine and, in a good brick, they are vitrified in a virtually homogeneous mass of practically uniform density. The assumption, however, that good paving brick are noticeably stratified and that the brick set in one way present vertical stratification has given rise to the term



WIRE-CUT LUG BRICK--BITUMINOUS BOUND FOUNDATION

BITUMINOUS OR CEMENT FILLER

vertical fibre. As a matter of fact, the term vertical fibre applies to a method of construction rather than to any structural characteristic of the brick itself. If a paving brick shows any appearance of stratification it is due to laminations, which are recognized as imperfections.

Monolithic brick pavements possess several advantages over other types, whichever method of construction is employed. It has a greater strength per inch of depth, thereby rendering it feasible to reduce the depth of foundation without sacrificing required load-bearing strength or durability. It is practically noiseless; it averts weather hazards during construction; it eliminates side edgings; it obviates defects arising from material coming up into the joints and preventing the bonding material from penetrating to the bottom of the joints; it overcomes shifting or shrinking of the bedding course, and—a feature of the utmost importance just now—it economizes time in construction.

Speedy Construction

In these times of highway transportation of domestic commodities and war supplies, speedy construction of durable highways is of prime importance.

Where a green concrete base is used, brick pavements can be built rapidly if the contractor has adequate equipment and an efficient organization. All constructional processes go on simultaneously. That is to say, the preparing of the green concrete base and the laying, rolling, inspecting and grouting of the brick are all being done at the same time within a distance of 50 lineal ft., so that at the end of each working period the pavement is finished as far as any work at all has been done, excepting the preliminary grading and the placing of temporary side forms.

Output Per Day

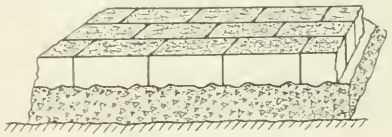
As no side edgings are required for highways, it is not uncommon for an organization of 25 men, aided by good mechanical equipment, to build 700 sq. yds. to 800 sq. yds. of monolithic brick pavement, with a 4-in. concrete base, in 10 hours. One contractor is reported to have built 1,000 sq. yds. of monolithic pavement in a working day, using mechanical conveyors for delivering the brick to the pavers; but the writer does not know the numerical strength of that contractor's organization.

The foregoing figures represent possible achievements rather than reasonable expectancy. Nevertheless, concentration of constructive energy within a small area, the elimination of periods of waiting for one portion of the work to set up before another step can be taken, the absence of weather hazards and the omitting of side edgings all combine to expedite construction.

When the sand cushion was used, a rainfall after the brick were laid, but before rolling, necessitated taking up the brick, re-preparing the sand cushion and relaying the brick; but rain does not damage green concrete foundations or cement-sand beds after the brick are laid.

Organization of Forces

Contractors are important factors in war-time construction in which the saving of time without detriment to good work is important. Contractors differ in their ideas of the number and distribution of men required in an organization. Local conditions often determine the arrangement. From 25 to 30 men is the rule for monolithic construction. In the smaller



WIRE-CUT LUG BRICK--VERTICAL FIBER TYPE

BITUMINOUS OR CEMENT FILLER

The Wire-Cut Lugs Embedded in the Concrete Foundation

organization each man should be highly efficient, there should be co-ordination of effort, and the mechanical equipment should be adequate.

Generally speaking, a contractor's organization large enough to construct from 500 sq. yds. to 700 sq. yds. of monolithic highway in a 10-hour day is made up as follows:

2 men—form setting.
8 men—concrete mixer.
1 man—finishing concrete surface.
2 men—dropping brick.
12 men—carrying brick.
2 men—culling and rolling.
4 men—grouting.

The number of men required for carrying brick can be re-

duced by the use of mechanical conveyors, if local circumstances justify their use. Sometimes the placement of brick conveniently allows retrenchment in the labor cost of handling. Each contractor organizes his force as he deems best, taking into account equipment, local conditions and the efficiency of the personnel, and depending somewhat upon his own organizing and executive abilities.

The men who lay the brick in the courses are factors in speedy construction. Brick should be handled quickly and placed properly without lost motion or waste energy. Twenty-five thousand or 30,000 brick a day is a good day's work for It is not unusual, however, for an experienced man to lay 30,000 brick in a working day.

Standard paving brick lay 40 to the sq. yd. Therefore, a man who lays 28,000 brick in a day surfaces 700 sq. yds., or approximately the yardage which a contractor's organization ought to construct, from base to grouting inclusive, in a 10-hour day on straight work, if the grading has been done and the forms have been put in place.

Standard brick of the wire-cut lug type weigh 9.3 lbs. each. A workman who lays 28,000 of these brick in 10 hours lifts—one brick at a time—and transports by hand a distance of at least 6 ins.—260,400 lbs. of vitrified brick, or 26,040 lbs. (13 tons) every hour. Obviously, ability to handle that amount of material properly involves a degree of natural aptitude, considerable expertness acquired by experience and steady application.

In monolithic construction, however, no portion of the work can be allowed to drag without impeding the progress of other portions or without prejudice to the pavement as a whole. The brick must be laid before the green concrete foundation takes its initial set and the grouting should be finished soon enough to assure a simultaneous setting up of foundation and cement-grout filler. This necessitates that the foundation unit keep out of the way of the bricklayers and that the rolling, inspecting and grouting units keep close up to the bricklaying. It is up to the contractor to perfect an organization in which all units co-ordinate.

Choosing Proper Grades for Various Types of Pavements

By Wm. Alden Brown, Assistant Engineer, City Engineer's Department, Providence, Rhode Island

The object of the present discussion is not to go into the relative merits of the numerous available types of pavement, but rather to consider their adaptability to various grades.

Durability, Cleanliness and Safety Depend on Grades

Any pavement to be at all satisfactory must, of necessity, be durable, clean and safe. Noiselessness is another important element as is also the question of repairs where broken into by the various public utilities. Now a pavement may be durable and safe on one grade but lacking in durability and entirely unsafe on another. The question of cleanliness, at least in a city, is not so much a matter of grades, when we use the term grades to mean the longitudinal rise of the street, as it is a matter of the contour or crown of the pavement, and the frequency of catch basins and inlets, closely supplemented by the work of the street cleaning department, said Mr. Brown in addressing the Municipal Engineering Section of the Providence Engineering Society.

Noiselessness is not much affected by grades. A given pavement will be noisy or noiseless according to traffic rather than grade, the number of horse drawn vehicles determining the relative noiselessness very largely. And the fifth requisite for a good pavement, that of repairs, is not a determining factor in selecting a pavement for a special grade.

Durability and safety then, if we exclude the matter of cost, are the two important factors in determining what pavement is best suited to a given grade.

Maximum Limits for Satisfactory Results With Grades

In the "Proceedings of the American Society of Civil Engineers," published in December, 1916, it is stated that "Conservative practice has fixed the maximum limits for satisfactory results with grades, as follows:

For gravel or broken stone	12%
For bituminous macadam	8%
For sheet asphalt	5%
For cement-concrete	8%
For brick (cement grout filler)	6%
For brick (bituminous filler)	12%
For stone block (cement grout filler)	9%
For stone block (bituminous filler)	15%
For wood block	4%

Waterbound Macadam

Considering these various pavements for a moment as they have hitherto been laid in Providence we find that we have waterbound macadam streets as steep as 13, 14 and 15% in several instances and in one case up to 16.5% in comparison with 12% recommended by the American Society and the fact of our having this type of pavement on these excessive grades constitutes a serious local problem.

Bituminous Macadam

Bituminous macadam, a type of pavement not suited to heavy traffic, but entirely satisfactory for light or medium traffic has been laid in Providence on a grade of 6.04% this being well within the 8% of the American Society and it would seem to the writer that 8% is rather steep for this pavement.

Tar Macadam

In Fall River, Mass., on Cherry St., tar macadam is laid on a 7% grade and, according to a statement of City Engineer Albert Wolstenholme, it has proved very slippery in winter. He adds, however, that too great a quantity of tar was used. He has found it necessary to have men with picks cut out parallel depressions about 6 ins. apart across the street so as to give a foothold to horses. Allowing, then, for a possible faulty construction, 6.5% insead of 8% would seem as steep a grade as should be paved with bituminous macadam.

Sheet Asphalt.

Sheet asphalt in our city has been laid on the approaches to the Union Station on grades over 4% and on Chalkstone Ave., being laid this year we have asphalt on a 7% grade on a partial width of the roadway in comparison with 5% as recommended by the American Society. In Syracuse, N. Y., the rule is that asphalt may be used for the whole width between curbs on grades up to 5% while on grades from 5% to 10% a strip of asphalt is laid in the center and on the outside granite blocks or brick are used.

Granite Blocks

Granite blocks with cement grout filler have in at least one instance been laid in Providence on a grade in excess of the 9% recommended by the American Society but on our steeper grades where this type of pavement is used, the joints are drawn as soon as the grout obtains its initial set.

Wood Blocks

The use of wood blocks in this city has for the most part been on grades of less than 2%, although on Brook Street, they are laid on a grade of 4.38% thus surpassing the 4% of the American Society very slightly.

Bituminous Concrete

The American Society recommends for bituminous concrete a maximum grade of 8% and we infer that the Warren Brothers "Bitulithic" pavement is included under this heading.

In Providence bitulithic has been laid on a grade of 5.19% which is a very conservative use of this pavement.

A writer on bitulithic says, "not only has the pavement proved a success on level surfaces and medium grades but

it has been found that by using a surface mix of a coarser layer than is customary on ordinary grades it will give a firm foothold for horses on grades as steep as 12%."

Steep Streets in Providence

My belief is that, on a grade steeper than 8%, while bitulithic might be relatively safe and suitable, a conservative judgment would decide that some other type of pavement would be better. A very serious problem in Providence is the final disposition of such streets of excessive grades as College, Waterman, Angell, and Thomas. These important streets are now built with plain macadam. It is felt that this pavement is unsatisfactory and in this decision we are in accord with the table of the American Society.

The objection to the macadam is lack of durability. A great change in paving has come about with the increase in use of the automobile and while under horse drawn traffic, the macadam on these streets proved moderately durable and entirely safe, it is now worn out with surprising rapidity.

In connection with the final disposition of these streets, it may be interesting, in addition to the recommendation of the American Society for similar grades, to refer to some of the correspondence of Mr. Bronsdon on this subject and also to a letter from Mr. Henry C. Allen, City Engineer of Syracuse, N. Y., to myself.

In a letter to Mr. Bronsdon from Mr. W. L. Weeden, Field Secretary of the Granite Paving Block Manufacturers' Association, in reference to College, Angell, Waterman, and Thomas Streets, he says, "In reference to a permanent paving, would say, that there is no question in my mind as to the advisability of paving these streets with such a material. In my personal opinion, granite will work out to the best advantage."

In a letter to Mr. Bronsdon from Mr. C. D. Pollock, consulting engineer, New York City, considering the paving of the steep Providence streets, the writer recommended "a narrow granite block as the paving material best suited to the grades and the traffic, and the joints should be filled with asphalt cement and sand, or with a mixture of asphalt, pitch, and sand. The cement, grout filler is suitable on lighter grades, but the bituminous filler will give much more satisfactory results on these grades."

An opportunity exists on Waterman Street, between Benefit and Prospect Streets, which has a grade of less than 10%, to adopt in part the recommendation, contained in the two letters quoted which do not conflict with the table of the American Society and in part a practice similar to that now in use in Syracuse, N. Y., and to which I have already referred.

On Waterman Street, which is 30 ft. between curbs, two strips 10 ft. wide of hillside brick with joints filled with bituminous filler and a strip of granite blocks in the center of the same width with joints also filled with bituminous filler would in the opinion of the writer be a very desirable change from the present macadam.

A more complete talk on grades must of necessity take into account the contour or crown suited to various pavements also modifications of the crown to meet the requirements on a flat or a steep grade and in addition a discussion of the various ways of grading intersections so as to dispose of the surface water, all of which topics I have omitted.

WATER WORKS DESIGN AND CONSTRUCTION

Design and Construction of the New Municipal Dam and Hydro-Electric Power Plant at Fort Dodge, Iowa

By Robert E. McDonnell, of Burns & McDonnell, Consulting Engineers, Interstate Building, Kansas City, Mo.

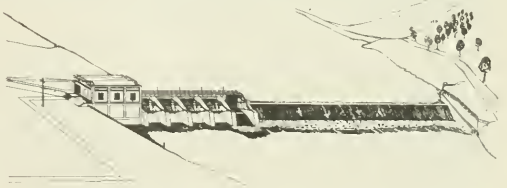
The city of Fort Dodge, Ia., with about 30,000 population and located on the Des Moines river, conceived the idea of building a municipal dam, with two objects in view: First, a financial investment that would be profitable to its citizens from the sale of power that would be developed; and second, the creation of a lake that could be utilized for pleasure purposes.

Fort Dodge being an inland city and a long distance from any body of water, the lake idea for fishing, boating and bathing proved to be very popular, but the citizens were determined that the project should be municipally owned and controlled. It was advocated by private parties with a franchise in view, but this was defeated at the polls, and after two unsuccessful efforts the city finally voted bonds for the municipal project. The feasibility of the project was patiently explained and exploited by Mayor John F. Ford for a number of years before the public became fully aroused as to its necessity.

Campaign for Bonds

The campaign for the bonds, under the auspices of the Commercial Club, was an interesting feature of the entire enterprise. The engineers transferred their preliminary plans, estimates and all data to stereopticon slides and these slides were shown at mass meetings previous to the bond election. The slides showed the proposed sites and also pictures of how the dam would look after construction, and with these illustrated lectures given by the engineers the citizens were enabled to vote intelligently on the project.

The bond issue for the improvements carried by a large majority, and on the 17th of June, 1916, contracts were let for the construction of the dam to the Koss Construction Company, of Des Moines, Ia., and for the power equipment and machinery installation to the Merkle Machinery Company, of Kansas City, Mo. The difficulty of carrying on the construction work through the scarcity of materials and labor, together with the handicap of high water and ice, made the whole project one of unusual difficulties in completion.



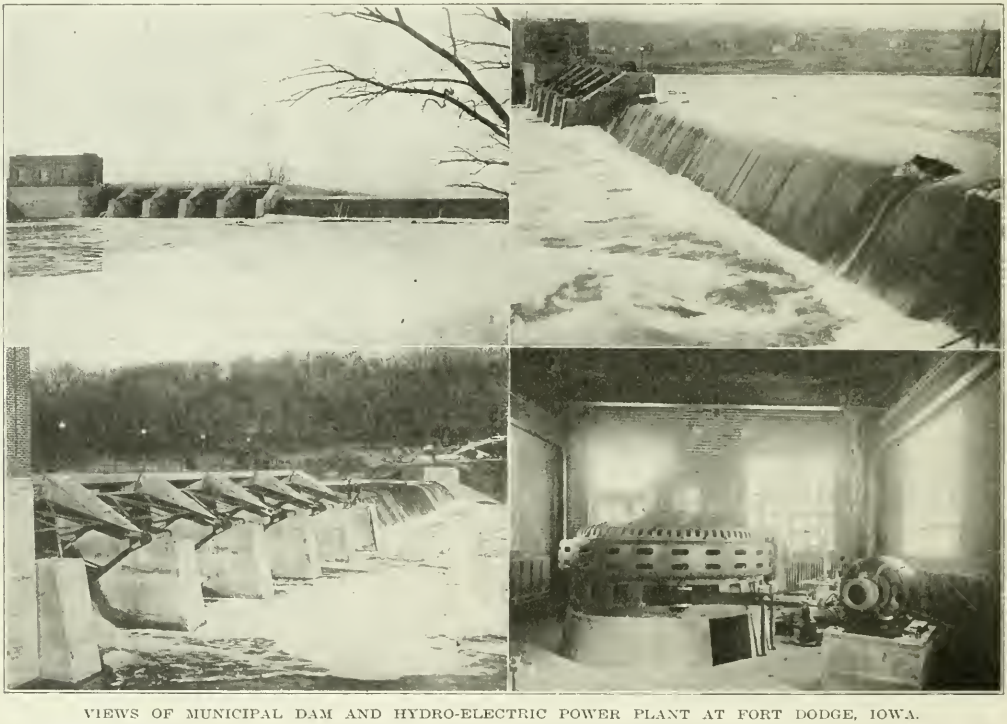
PRELIMINARY SKETCH MADE TO SHOW PROPOSED DAM, FOR USE IN CAMPAIGN FOR BONDS.

Design Features

The spillway section of the dam is 230 ft. long and is of solid concrete construction. One hundred and thirty feet of the dam consists of five sluice gates of the Tainter type, built of structural steel, with a radius of 17 ft., and arranged so that all five gates may be raised by a motor-propelled electric

hoist, allowing the flood stages of the river to pass through the gates, thus avoiding overflowing large areas of land that would otherwise be inundated at flood stages of the river. The dam has a height of 18 ft. above the bedrock of the stream, with a concrete toe 4 ft. deep and 3 ft. wide on the up-stream side. The concrete portion of the entire structure is 412 ft. wide, including a concrete fish-ladder at one end, as required by the state law of Iowa.

The raising and lowering of the gates controls the water level above the dam during high-water seasons, and they also control the water level above the dam in the winter and can be manipulated in order to avoid the structure being damaged by breaking ice in the spring.



VIEWS OF MUNICIPAL DAM AND HYDRO-ELECTRIC POWER PLANT AT FORT DODGE, IOWA.
Left to Right: Downstream View of Power House, Gates and Spillway—View Along Crest of Spillway—Close-up View of Tainter Gate Section—View of 500-h.p. Turbine.

Damage from Floating Ice

The concrete spillway of the dam was finished the 28th of February, 1917, and on March 21, three weeks afterwards, while the gates were open, a heavy mass of ice came down the river with so much velocity that it tore out the walls of the head-gate chamber and damaged the structure considerably. Before the gates could be closed large blocks of ice several feet thick passed over the dam, and the water on the down-stream side of the dam being low, the ice went over the dam without any cushion of water to break the force of the blocks of ice dropping over the dam. This grinding and hammering effect of the large blocks of ice on the toe of the dam caused a large hole to be scoured out on the down-stream side of the dam. The limestone was fissured, and through these fissures in the bedrock streams developed which scoured out a large opening under the dam.

Considerable damage was done before the gates could be closed and the water raised, so that the water then passed over the crest of the dam and the ice was given a cushion to fall upon as it passed over the structure, and prevented further damage.

Repairing Hole Under Dam

The repairing of the hole under the dam was accomplished by driving steel sheeting on the up-stream side of the dam and a cofferdam on the down-stream side of the dam, and the hole, which was about 60 ft. in length and high enough for a man to walk through, was poured full of concrete and a reinforced concrete apron was constructed on the down-stream side of the dam. The solid concrete dam for several months formed a perfect arch over the hole of the dam before repairs could be completed. The high-water stage of the river was passed before the repairs could be completed, thus adding another danger in carrying out the construction work. The entire repairs were finally finished on December 14, 1917, tested out and accepted by the city on March 1, 1918.

Cost of Project

The total cost of the project, including power house, turbine, generator and transmission line, was approximately $130,000. Careful examination showed the original structure of excellent construction, and the fact that the dam, for a stretch of 60 ft. from span to span over the opening, containing 3,500,000 lbs. of concrete, withstood the strain, seems to be ample evidence that there was nothing faulty about the concrete work.

Power Used to Pump City Water

The power house is of brick and reinforced concrete construction, 56 ft. long and 22½ ft. inside width. One 500-h.p. vertical turbine of the Francis type was installed and foundations are already built for a second unit, which will be in-

stalled later, giving a total development of 1,000-h.p. The power is transmitted to the water works station about three-quarters of a mile below the dam and used for pumping the water, and since placing the plant in operation the city has accomplished a saving of approximately $40 per day on fuel alone. Arrangements are being made for selling the surplus power, as there is a good demand for the power at a number of mills and factories close by.

The lake formed by the backing up of the water is about eight miles in length and will average 500 to 600 ft. in width. The wooded hills on each side of the stream and high bluffs at various points add to the attractiveness of the lake, and it is believed that the spot will prove especially attractive not only to the citizens of Fort Dodge, but to surrounding communities, who heretofore have been compelled to travel hundreds of miles to visit any recreation spot.

Personnel.

The design and supervision of the work was carried out by Burns & McDonnell, consulting engineers, of Kansas City, Mo., with Mr. Leland C. Angevine, resident engineer in charge of construction, who has since been retained by the city and placed in charge of the operation of the municipal power plant.

The entire municipal project is an excellent example of the accomplishing of both utility and attractiveness by procuring a power plant that is revenue producing, and at the same time providing a beautiful lake and pleasure resort that will be enjoyed by the entire community.

Cost of Machine Trenching Under Difficult Conditions for Water Mains and Services at Erie, Pa.

By Ed. W. Humphreys, Superintendent of Water Works, Erie, Pa.

When the General Electric Co. of Erie became heavily involved in government work, the housing question assumed gigantic proportions. Cost then became a matter of secondary consideration and urgent demands were made upon the city water department to rush to completion the installation of water mains and services.

Winter Work

It has been our rule to abandon all construction work during the winter months. This year, however, because of unusual conditions, the ruling was set aside and work was continued in spite of the severest weather of the past twenty years.

Soil in this operation consisted of a 3½-ft. layer of yellow, sticky clay, underlying which is a 4-in. layer of soft sandstone, which is immediately over some 3 or 4 ft. of hard blue shale. Frost had penetrated to the rock at all points of the operation and alternate thawing and freezing in the early part of the winter left a coating of almost solid ice to a depth of 3 or 4 ins.

The usual cleats used on this machine were V-shaped across the full 24-in. face of the wheel, and ordinarily would leave an imprint approximately an inch wide and 1½ ins. deep. It was, however, impossible to obtain any traction with these cleats, and even with the 19 tons tending to bear them into the ground, no impression was left on the mass of ice under the wheel.

Numerous experiments were tried to overcome this condi-

TABLE I—COST OF OPERATING TRENCHING MACHINE BY ERIE (PA.) WATER DEPARTMENT FROM MAY 1, 1917, TO JAN. 3, 1918 (EXCLUSIVE OF OVERHEAD, DEPRECIATION AND REPAIRS).

Operator—	Rankine Ave., N.	Rankine Ave., S.	22d, W. of Cranberry	28th, W. of Sigsbee	Cherry, N. of 30th	5th, W. of Raspberry	27th, W. of Cascade	Old French Rd.
Hours	62	26	4	3	2	3	2	1
Amount	20.15	9.10	1.40	1.05	.70	1.35	.90	.45
Labor—								
Hours	115	38	4	3	2	3	2	1
Amount	34.50	10.15	1.30	.83	.55	.98	.70	.35
Watch'n—								
Hours	50	101	29	63	29	89	15	14
Amount	13.75	20.20	5.80	12.60	5.80	22.25	3.00	2.80
Gasoline—								
Gallons	39	35	15	12	10	12	8	4
Amount	9.47	8.75	3.78	3.02	2.52	3.02	2.01	1.00
Oils—								
Quarts	4	4	3	4	3	1	1	1
Amount	.38	.46	.34	.46	.34	.10	.10	.19
Grease—								
Pounds	2	1	1	1	1	1	1	0
Amount	.15	.09	.09	.09	.05	.05	.05	.00
Total cost	78.40	49.05	12.71	18.05	9.96	27.75	6.76	4.79
Lineal ft.	1,000	800	665	652	360	400	420	230
Cost per ft.	.078	.062	.019	.027	.028	.069	.016	.021

VIEWS OF P. & H. TRENCHING MACHINE IN SUCESSFUL OPERATION UNDER ADVERSE CONDITIONS BY ERIE (PA.) WATER DEPARTMENT.

Upper, Left to Right: Machine Digging Trench 24-in. Wide, 5½-ft. Deep, Through 44-in. of Frost and 22-in. of Shale—Machine in Operation and Sewer Trench Cut by Different Type of Machine—Another View in Same Locality. Lower Row: Extensive Housing Operation in Its Infancy—Machine Operating at Speed of 3½-ft. Per Minute and Cutting 26-in. of Shale—An Idea of the Soil Conditions and Difficulties to Overcome.

tion without success until we made cleats of 3-in. special angles, sharpening the cutting edge to facilitate its entrance in through the ice. A working speed of 1½ ft. per minute was the best rate we could attain.

Another obstacle in the way of successful and economical operation was the proximity of the sewer trench, which the photographs indicate.

In spite of all these things and with a crew consisting in all of nine men this 2,280 ft. of main was finally installed, and while the cost was under the conditions well within reason, we withhold mentioning the amount because it would involve a lengthy description and detailed explanation.

As an example of what the Pawling & Harnischfeger trenching machine accomplished on this work its performance on February 20, 1918, may be cited. On that day the machine dug a 2-ft. trench, 5½ ft. deep, through 44 ins. of frost and the remainder through a hard shale at the rate of 1½ lineal ft. per minute.

Performance Data on Trenching Machine from May 1, 1917, to Jan. 3, 1918

In Table I herewith are given data on the actual cost of operating this trenching machine from May 1, 1917, to Jan. 3, 1918, exclusive of overhead, depreciation and repairs. The table itemizes the actual operating costs on eight jobs of medium length.

Some Special Features in Recent Water Tank and Tower Construction

By Max Whitacre, Contracting Engineer, Pittsburgh-Des Moines Steel Co., First National Bank Bldg., Chicago

The four steel water tanks illustrated herewith, each possessing a special feature, have been erected recently by the Pittsburgh-Des Moines Steel Co. Following is a brief statement of the distinguishing characteristics of each installation:

RECENT WATER TANKS WITH NOVEL FEATURES. Left to Right: (Top) Anchorage, Alaska; Pearl Harbor, Hawaii; (Bottom) Alliance, Neb.; Albany, Minn.

Alliance, Neb.—This is a 20,000-gal. tank erected on a 30-ft. steel, hemispherical bottom tanks on an 80-ft. steel tower. This tank was erected on the corner of the building, making it necessary to support two columns on a truss as shown.

We have installed a large number of steel sprinkler tanks on buildings requiring special towers, and most up-to-date concerns are requiring their sprinkler tanks to be of steel.

Anchorage, Alaska—This is one of our standard 100,000-gal. steel, hemispherical bottom tanks on an 80-ft. steel tower, erected for the city of Anchorage, which is a terminal of the Government Railroad running back into the extensive Alaskan coal fields.

This is the first steel water tank to be erected in Alaska, and one interesting feature, which is not found on the usual tank, is the frost casing which completely covers the tank. On account of the severe weather experienced in Alaska this covering is required and it has proven satisfactory in every way.

Pearl Harbor, Hawaii—This is a 250,000-gal. steel, hemispherical bottom tank on a 110-ft. tower erected for the United States Navy Department at their hospital. This tank required no frost casing for riser pipe as the weather is not severe.

The special feature is the walkway which permits the inspection of the expansion joint. A valve was installed next to the tank bottom permitting the tank to be shut off in case repairs were to be made to tank riser or water mains.

The United States government requires steel tanks to be installed at all permanent stations or hospitals.

Albany, Minn.—This was a replacement job. We originally furnished and installed a wood tank for the town of Albany 18 years ago. The wood tank becoming unsafe on account of rot, we removed it together with the steel deck beams and by installing additional columns on the old tower were able to put on a new 50,000-gal. steel, hemispherical bottom tank.

The town now has a steel tower and tank 50x100, which is as good as a complete new structure as the old columns were in very good condition.

We have replaced about 150 wood tanks with steel, using about this same form of construction.

Construction Plant and Methods Employed in Building the Reinforced Concrete Reservoir at Highland Park, Mich.

By Paul Teas, East Ohio Gas Bldg., Cleveland, Ohio

Highland Park, Mich., adjoining Detroit and the seat of the Ford Motor Company's great industrial plant, has a population of about 20,000. The city plans to grow and in planning public improvements to meet future needs they are made large enough to take care of future growth. The handling of the enlarged water storage facilities is a case in point. The new reinforced concrete reservoir has a capacity of 45,000,000 gals and it is estimated that this will provide ample storage for years to come. The superceded reservoir now serves a coagulation basin. At the present rate of consumption the new reservoir will hold a four days' supply.

Design Features

The new reservoir measures 1,373 ft. long by 294 ft. wide by 14 ft. deep. It is supplied from an intake crib and pumping station on Lake St. Clair, eleven miles away, from which the water flows to the reservoir by gravity. Another set of pumps at the reservoir delivers the filtered water over Highland Park.

It is pleasing to note that the plans upon which this system was laid out, and the methods employed in building it, were in keeping with its importance—the Highland Park Reservoir enjoys the distinction of being one of the largest projects of its kind in the United States. Great credit belongs to Messrs. Lawrence Whitset, city engineer; Harry Hulbert, superintend-

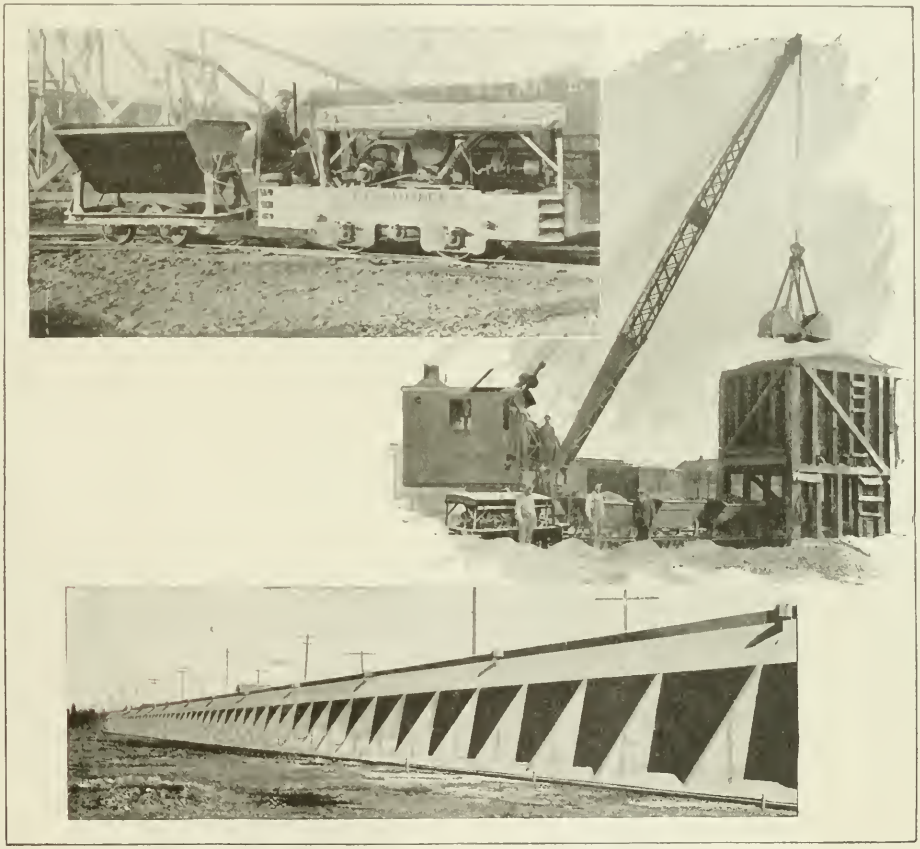
cut of public works; E. J. Lieber, engineer in charge of construction, and George L. Wright, concrete and steel foreman, for the thorough-going way in which the work was planned and carried out.

It was put through by the city on direct contract, and so thoroughly were all the details planned and so co-ordinated that approximately $15,000 was saved on a single section of the work.

included 22 industrial cars. In the storage yard were the main track and a number of spurs.

The material was unloaded from the gondolas by a locomotive crane and clamshell bucket, and stored in elevated bins from which it was unloaded into the industrial cars by gravity and delivered to the mixers right on the reservoir floors.

A notable point about the pouring was the fact that the



CONSTRUCTION VIEWS OF WATER WORKS RESERVOIR AT HIGHLAND PARK, MICH.
Gasoline Locomotive Hauling Industrial Car—Locomotive Crane and Clamshell Bucket Unloading from Gondola Cars to Elevated Bins over Industrial Railway Track—Section of Finished Wall.

The design of the reservoir itself, the construction features entering into it and the facilities employed to keep things moving efficiently, are all in harmony with the importance of the work from the standpoint of immediate and future needs.

Construction Plant Employed

On every hand as one views this concrete structure is evidence of the builders' dependence upon machinery to do all the important work—accurately, thoroughly and in a big volume.

The excavating was done with three steam shovels—and that gives a key to the plan on which the whole job was put through. Inside the reservoir was a complete system of industrial railway, which kept the "front lines" supplied as the work advanced.

Two gasoline locomotives, of the type shown in the illustration, furnished the tractive power, and the equipment also in-

mixers were so spouted as to cover a 50-ft. strip of floor at each pass—25 ft. at either side. Very little hoeing was required to get the concrete in place and an average of 10,000 sq. ft. a day was easily maintained.

Liberal credit is given by the builders to the efficient transportation system, which permitted unloading the materials from the railroad at one point and rehandling it economically as the work advanced.

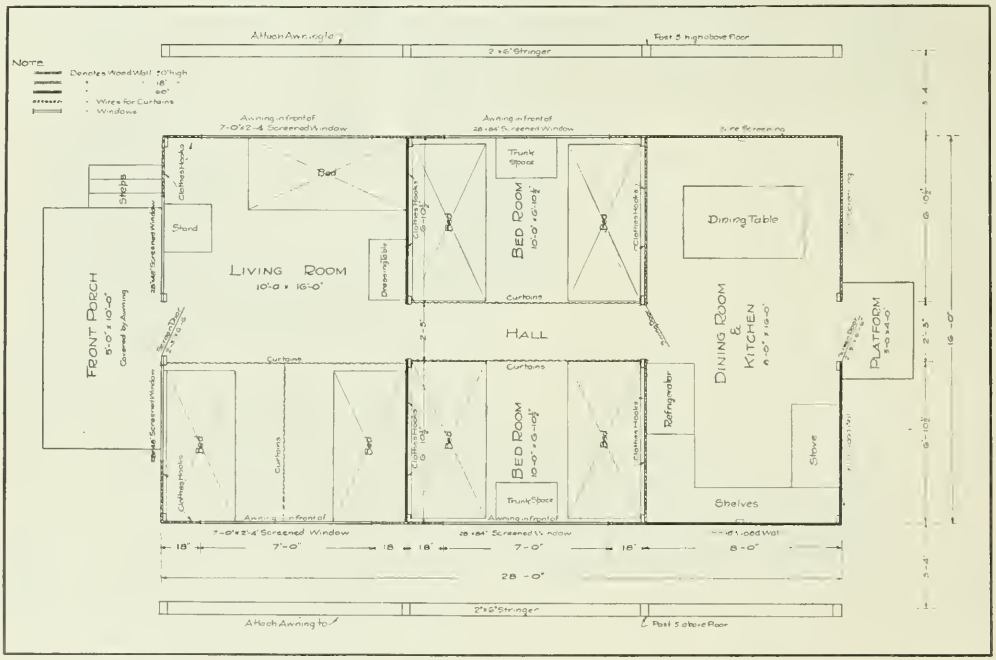
Some of it, of course, had to be carried the maximum distance, and one section of the reservoir wall was left open until the very last to permit the trains to pass through; but the locomotives did their part well, the work progressed rapidly and economically right through to its conclusion and modern industrial haulage has another success to its credit.

SEWER DESIGN AND CONSTRUCTION

Water Supply and Sewerage of Recreation Camps at Lake Geneva, Wisconsin

By W. S. Shields, Consulting Engineer, 8 South Dearborn St., Chicago

The engineer called upon to design sanitary improvements for summer outing camps finds it difficult to find much printed matter containing suggestions or requirements relative to the matter. The writer has had an opportunity not only to work out plans for such improvements, but to see them installed and to watch their maintenance through years of operation and to remedy defects and add improvements thereto.



PLAN OF HUT AT RECREATION CAMP, ALSO SUITABLE FOR USE IN CONSTRUCTION CAMPS.

Three Camps at Lake Geneva

At Lake Geneva, Wis., one of the most beautiful of the lakes accessible to Chicago's people, may be found several such camps. Three in particular are here mentioned, viz.: The Y. M. C. A. Training School, the Eleanor Association and Olivet Institute. The Training School has a capacity for caring for some 800 guests. They provide tents accommodating eight persons, four beds, and eat at a central dining hall. The Eleanor Club is a working girls' club of Chicago, and the camp is managed to give the girls some two weeks of outing at cost. They use a four-bed tent similar in size and arrangement to those at the Y. M. C. A. This camp has a capacity for accommodating some 200 girls and attendants.

The Olivet Institute is a religious organization doing an important work among the foreign element of the city. Its work is in one of the most thickly populated districts of mixed foreign element, a veritable melting pot of the nation. The institution has a yearly budget of some $50,000, and besides providing educational, medical and other public welfare work, has acquired a holding on the shores of Lake Geneva, where camp improvements have been made and where they are able to send the women and children of its parish out for a few days' outing. In order to maintain this expense they have also provided accommodations for pay guests, who are housed in four-room tents, as at the other camps, and fed at a central dining hall; they have also provided a number of tents and huts where families do housekeeping. These families, generally well-to-do people, come and spend from one to two months during the summer season. The camp has facilities for caring for some 200 or 300 guests.

The three camps are all located near each other on the northern shore of the lake. The shore is wooded and rather broken, extending back to a bluff which is 100 or more feet high at a distance from 500 to 1,000 ft. and more from the shore. The occupied section is along the shore where the ground is suitable for habitations.

Water Supply

Extensive gravel beds are found in the banks and many springs entering the lake at short intervals supply drinking water and keep the lake pure and fresh.

The camps are supplied with lake water for general use; it is pumped into concrete reservoirs built in the bill back of

the camp and distributed by small pipes laid just beneath the surface to faucets, each of which supply three or four of the tents and huts. The pipes are arranged to be drained during the winter and a main cast-iron pipe leading from the pumping station to the reservoir is generally located so as to furnish water to fire hydrants at important points.

Drinking water is obtained from the springs or from wells. At the Y. M. C. A. camp a heavy flow spring, which comes from a bank near the water level of the lake, is lifted by a small water lift pump, operated with water from the main reservoir; this pump lifts the spring water into a separate concrete tank placed to such an elevation that it is carried to the kitchen, dining rooms and drinking fountains by gravity. At the Olivet camp the drinking water is secured from a spring at

TYPE OF HUT FOUND SATISFACTORY AT LAKE GENEVA RECREATION CAMPS AND SUITABLE FOR USE OF ENGINEERS AND CONTRACTORS IN CONSTRUCTION CAMPS.

a sufficient elevation so that it is conveyed into a concrete reservoir feeding the camp by gravity, while at Eleanor the drinking water is at present supplied from a well pumped by hand.

Sewerage

As the entire slope leads directly to the lake the question of sewerage was the most difficult one. This was accomplished by constructing tile sewers, mostly 6 in. in diameter, leading from the various toilets through septic tanks to a common point and to one side of the grounds, where a concrete storage tank is provided and from which the sewage is pumped back into the hill into a series of dry wells excavated in the gravel banks. The pumping plants consist of a combination gasoline pump and engine, which lifts the lake water into the reservoir; this machine is provided with a pulley for driving a small pump, which pumps the sewage from the storage tank, when filled, back to the dry pits. The pits are formed by excavating some 10 to 12 ft. down into the gravel beds and lining the pit, some 5 to 6 ft. in diameter, with a dry wall of sewer brick. By thoroughly cleaning these pits a month or six weeks prior to their being put into use, they have given excellent service through a period of 10 to 12 years.

After trying various and less expensive methods for outside closets and toilets the most satisfactory one, and that now universally adopted, is that of the standard low tank flush closet, and a sufficient number of these toilets, some for men and others for women, have been located at different points through the camps to be reached conveniently from all the tents. It has been found sufficient to provide one toilet seat for each 25 persons at the camp. The toilet buildings are of sufficient size to provide rest seats and lavatory bowls. In the camps where a large number of children from the tenement districts have been cared for the sanitary arrangements have proven entirely satisfactory and are a great source of comfort and security to the campers.

The writer has acted as chairman of the grounds committee of the Olivet camp for several years, and a study on the grounds of the needs and preference of the campers, has made it possible to meet the practical demands and to please the great majority of those who come from year to year for their summer outing.

Housekeeping Hut

The most popular housekeeping hut is that shown in the accompanying cut. This one is 16 ft. wide by 28 ft. long over all; board floor supported on posts, with sides walled with siding to a heighth of 30 ins., with 2x4-in. studs 5 ft. high supporting a 2x4-in. wall plate. Doors are framed in each end and supports provided for a ridge pole. This frame is then covered with a canvas tent and fly, the side walls of the tent drop to meet the side boards on the outside. Window openings 5 to 6 ft. by 28 ins. high are provided by constructing overlapping flaps in the side walls of the tent cover. These openings are formed of 2x2 uprights, extending from the floor to the wall plate, one on each side the opening, to which is attached on the outside a fly screen and a curtain rod on the inside for closing the opening when desired. The loose portion of the wall flap may be raised as an awning or dropped and the opening closed as desired.

The interior is divided off to suit the occupant; this plan shows a satisfactory arrangement. The partitions are of inexpensive curtain material supported on soft wire stretched across the tent, leaving a narrow passageway connecting the living room with the kitchen and dining room, which is boarded on one side and screened on the other.

The beds may be single cots or double-deck cots as desired. The association furnishes the cots, mattresses, chairs, table, gasoline stove and some dishes, the camper the rest of the necessary equipment. Huts of this type in ordinary times can be constructed for $150 to $175 each and will readily rent, including the outside conveniences furnished by the association, at $55 to $60 per season. This type of hut is also recommended for engineers' and contractors' use in construction camps.

The camps are daily inspected and stringent rules are enforced to maintain cleanliness and sanitary conditions. Garbage is collected daily and provisions delivered by local merchants and farmers.

Design and Cleaning of Sewer Catch Basins

Referring to the article published under this title on pp. 147 and 148 of MUNICIPAL ENGINEERING for April, attention is called to the fact that the address of the author, George A. Carpenter, is Pawtucket, R. I., instead of Providence, R. I., as given. Mr. Carpenter is, and for many years has been, City Engineer of Pawtucket.

Method and Cost of Making Tight Joints in Pipe Sewers

By W. W. Dixon, The Atlas Company, Lincoln, N. J.

National and state laws governing the pollution of streams with sewage have caused municipalities throughout the country to install expensive disposal plants for sewage treatment, and many of these plants, owing to topography, are compelled to install pumps to discharge the sewage after treatment. This is a very material item in the annual budget when we consider infiltration data as printed in Proceedings of American Society of Civil Engineers, Vol. LXXVI, and National Association of Cement Users, Vol. XII.

Importance of Reducing Sewer Infiltration

A vast amount of study and thought and a very considerable sum of money have been spent in the perfection of plants for the treatment of sewage. In a paper by Mr. W. H. Dittoe, chief engineer of Ohio State Board of Health, he places the cost of a disposal plant at 100 per cent. per capita above the cost of the sewer proper. Therefore, accepting the lowest estimate of experts on the amount of infiltration where cement joints are used, 33 1/3 per cent. of normal flow, we must nat-

urally increase the size of disposal tanks to treat ground water. Nevertheless, in the design of the sewer the cement joint is still very much in evidence, increasing the annual cost of maintenance. With the jointing cost of vitrified tile pipe sewer such a small part of the whole cost, and considering the known advantages and benefits deriving from a water-tight sewer, it is difficult to understand why a known leaky joint method is used, even if it is slightly cheaper than a material that will give results that will show an annual saving to the city. I have in mind one city in New Jersey where only a portion of the sewage reaches the disposal plant, this portion representing not more than 2,000 population, all dwellings, and the pumping records show in 1910-11-12 an average of 198,000,000 gals. pumped per year.

It is possible that I do not appreciate the fact that the tremendous infiltration of ground water through poor cement

DEMONSTRATION OF WATERTIGHTNESS OF G-K JOINTS IN SEWER PIPE. STOOD FULL OF WATER FOR 10 DAYS WITHOUT LEAKAGE.

joints dilutes the sewage, and, therefore, reduces the chances of pollution of streams if discharged before proper treatment due to the fact that the plant is not of sufficient size to care for the heavy flow, but on this point I do not consider myself qualified to present an opinion.

This condition has caused the writer to invent and introduce to the engineering profession G-K Compound, that has proven effective in stopping infiltration and at a cost no greater than if cement mortar were used.

Cost of G-K Joints

As to the question propounded of the cost of making G-K joints in vitrified tile pipe of the bell and spigot type, I take for example 8-in. standard pipe, the dimensions of which are known, having an annular space of ⅜ in. and a depth of compound of 1 in. This depth having been proven by tests to withstand a pressure of 29 to 35 lbs. per sq. in., means the material cost of the G-K joint at the price at which we are now quoting our compound, 1.69 cts. per joint. The advantage of G-K joint over cement joint is that (to use an expression that has lately come into vogue) it cannot be camouflaged. The cement joint, after the bevel has been wiped on the bell end, gives no evidence nor satisfaction to the inspector that the full annular space in the joint has been filled with mortar, as most specifications demand; while when G-K Compound is used, the inspector knows after a few joints have been made the volume necessary for a perfect joint, so he can stand on the edge of the trench and see that volume of compound poured from the vessel used, and has reasonable assurance that sufficient compound has been used to give a perfect joint.

Again, an item of saving in cost is evident. When two lengths are jointed on the bank, the joint so made sets up hard enough in a couple of hours to allow the lowering of two lengths as one into the trench, in this manner reducing the number of trench joints to one in four lengths of pipe, thus increasing speed in construction and the consequent saving in cost.

How Contractors Bid on G-K Joints

As to contractors' opinions on the subject of cost, we quote in Table I bids received at three lettings at Hagerstown, Md., where J. B. Ferguson, chief engineer, desirous of having work as nearly perfect as possible, called for alternate bids, the bid on G-K joint to cover 2-in. depth of compound:

Item 1—Vitrified tile pipe, per foot cement joint.

Item 1A—Vitrified tile pipe, 2-ft. G-K Compound.

The bids were the same in most instances, with exceptions in favor of the G-K joint.

A recent test was made by Thos. A. Bergen, city engineer of Auburn, of the use of compound. I do not know if G-K or some other compound was used, but the fact that the joints were poured joints and water-tight is the important item.

At Washington, D. C., John L. Rice, field commissioner of the Sewer Pipe Manufacturers' Association, made a demonstration of G-K poured joints before a group of government and city officials. He also made a demonstration at Columbus, O., which is illustrated herewith.

It is difficult to give cost data, as the average contractor does not consider the cost of jointing an important item, and reports we have received vary very materially, but with the known weight of G-K Compound per cubic foot and the known size of the annular space in the pipe to be filled, the actual material cost can be very quickly determined to a very small fraction.

An interesting article on the use of G-K Compound appeared in Municipal Engineering for September, 1912, entitled "Sewerage of Shelbyville, Ind." It gives no cost of jointing, but shows the saving to the contractor in pumping costs.

Eardley C. Cattley, resident engineer on the work at South Orange, Alexander Potter, C. E., New York City, designing and consulting engineer, places the cost of G-K joint in 8-in. deep and wide socket pipe at 14.68 cts. per joint 1½ ins. deep, but we must consider that at the time G-K Compound cost 6¼ cts. per lb., and the laborers using the compound were entirely unfamiliar with its use, and the sewer was laid below the ground water level in some cases, with a 3-ft. head. The infiltration was measured and only amounted to 400 gals. per sewer mile per day.

TABLE I—BIDS AT THREE LETTINGS AT HAGERSTOWN, MD., SHOWING HOW CONTRACTORS BID ON ORDINARY CEMENT AND G-K JOINTS IN PIPE SEWERS.

June, 1917

	Cement Joint					G-K Joint				
	27-in	15-in.	10-in.	8-in.	6-in.	27-in.	15-in.	10-in.	8-in.	6-in.
A	2.80	.93	.55	.50	.40	2.90	1.00	.65	.60	.45
B	3.45	1.20	.60	.40	.33	3.45	1.20	.60	.40	.33
C	3.50	1.60	.57	.50	.45	3.40	1.55	.55	.48	.43

September, 1917

	24-in.	18-in.	8-in.	6-in.	24-in.	18-in.	8-in.	6-in.
A	2.75	1.75	.50	.40	2.75	1.75	.50	.40
B	2.90	2.15	.52	.44	2.95	2.15	.53	.45
C	3.07	1.80	.48	.38	3.07	1.78	.48	.38

January, 1918

	22-in.	18 in.	12-in.	10-in.	22-in.	18-in.	12-in.	10-in.
A	1.80	1.20	.70	.50	2.20	1.40	.75	.60
B	2.75	2.00	1.68	.45	2.75	2.05	1.68	.45
C	2.70	1.75	.98	.79	2.75	1.80	.99	.79

New York Ordinance Requiring Oil Separator for Excluding Gasoline from Sewers

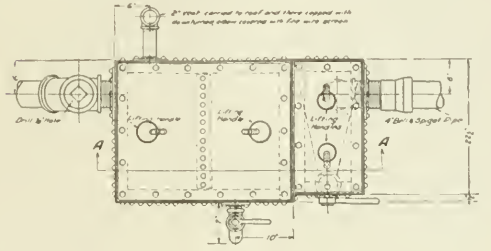
There is in force in the city of New York an ordinance requiring every garage where more than four motor vehicles are stored to install an oil separator or similar device to prevent gasoline from escaping into sewers where it would be likely to cause explosions. It is also prescribed that these separators be emptied and cleaned at frequent intervals. Owing to the precautions required by the ordinance the difficulties arising from gasoline in sewers have been much less than formerly. The ordinance requiring the separators has been declared constitutional by the Court of Appeals.

The New York fire department has issued plans, specifica-

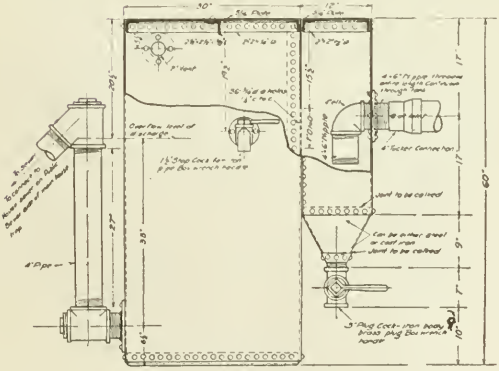
tions and regulations for an oil separator installation, the principal details of which are illustrated herewith.

Regulations Governing the Filing of Drawings, Descriptions, Etc., for Installation of Oil Separators

1. Drawings and triplicate descriptions, on forms furnished by the Bureau of Buildings and the Bureau of Fire Prevention for the installation of approved oil separators shall be properly filled in and filed by the owner or architect in the said bureau. The plans must be drawn to scale in ink, on cloth, or they shall be cloth prints of such scale drawings, and shall consist of a floor plan on which the separator is to be located, showing all windows and door openings, passages,



PLAN



SIDE ELEVATION & SECTION AA

PLAN, SIDE ELEVATION AND LONGITUDINAL SECTION OF OIL SEPARATOR TO KEEP GASOLINE OUT OF NEW YORK SEWERS.

walls, partitions, enclosures, stairs and elevator enclosures, location of boilers or other heating, lighting and power devices having an exposed flame or spark, gasoline storage system, exposures; a general floor plan showing location of separator, the various floor drain lines connecting to it, the relief, the discharge and its connection to the house sewer (if any), and that much of the house drain as will show the house trap and fresh-air inlet; a vertical section or sections showing this latter plan in elevation; a plan and as many elevations of separator and its connections as are necessary to show clearly in detail those connections; together with their various sizes, and, if the separator is located in pit, full details and dimensions of the same should likewise be shown. Ample clearance for inspection and maintenance between separator and pit must be shown.

2. The said installation shall not be commenced or proceeded with until said drawings and descriptions shall have been so filed and approved by the superintendent of buildings and the chief, Bureau of Fire Prevention.

3. No modification of the approved drawings and descriptions will be permitted unless either amended drawings and triplicate descriptions covering the proposed change or changes are so filed and approved by the chief, Bureau of Fire Prevention, and the superintendent of buildings.

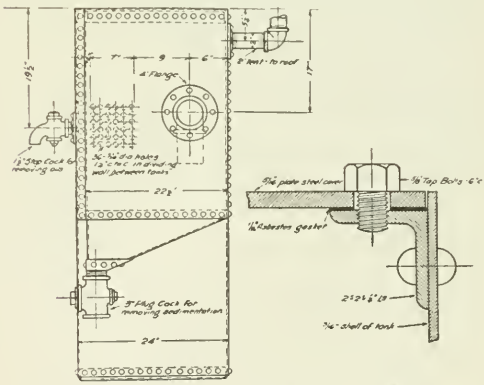
4. The installation in all buildings, both public and private, shall be executed in accordance with the rules and regulations of the Bureau of Buildings (all boroughs) and the Bureau of Fire Prevention.

5. Repairs or alterations of the separator and any other connection may be made without filing drawings and descriptions in the Bureau of Buildings and the Bureau of Fire Prevention, but such repairs or alterations shall not be construed to include cases where new vertical lines or horizontal branches of soil, waste, vent or leader pipes are proposed to be connected to the said separator.

6. Oil separators installed in any building where volatile, inflammable fluids are used, must be arranged to be readily accessible; where located underground, an iron, brick or concrete manhole must be provided with an iron or flagstone cover. They must not receive the discharge of house, outside court and area drains, toilets or leaders.

7. They must in all cases be connected by a Y-branch fitting to the house sewer on the public sewer side of house trap.

8. No separate trap need be provided on drain entering oil separators, but a running trap must be provided for each floor drain discharging to the separator.



DETAILS OF COVERS

ADDITIONAL DETAILS OF NEW YORK OIL SEPARATOR FOR KEEPING GASOLINE FROM ENTERING SEWERS FROM LARGE GARAGES.

9. When fixture or floor drains are located on any floor above the first, the lines to which they are connected must extend in full caliber at least 1 ft. above the roof coping, and well away from all shafts, windows, chimneys or other ventilating openings. When less than 4 ins. in diameter they must be enlarged to 4 ins. at a point not less than 1 ft. below the roof surface by an increaser not less than 9 ins. long, and the traps of all fixtures vented.

10. Relief pipes must be provided at least 2 ins. in diameter and carried independently above the roof, and there capped with down-turned elbow equipped with fire screen.

11. Drainage from washstand in garages shall not be permitted to flow into sump pits.

12. All piping must be left exposed until after the fire department inspections.

13. Oil separator pit shall be so located to prevent floor

drainage flowing into it, or else have concrete curbing around it.

14. Where a pit is below the ground water table and there is a possibility of water being in the pit, the lining should be made impervious.

Employing a Backfilling Machine of Special Design on Heavy Sewer Work in Chicago

When the Byrne Bros. Construction Company, of Chicago, took over the contract from the Sanitary District of Chicago for the construction of two sections of 17-ft. concrete sewer on the South Side, they worked out, in conjunction with the Weller Manufacturing Company, an arrangement by which each unit of expensive machinery employed on the job could work at the highest rate. By using the machine they devised,

SPECIAL BACKFILLING MACHINE USED ON HEAVY SEWER CONSTRUCTION IN CHICAGO.

the drag line excavators on the job were enabled to work from one position for a great length of time, thus cutting down the cost of moving.

The general method employed on this job was to have a steam shovel go down through the street and excavate a quantity of earth equal to the cross-section of the finished sewer.

This operation was carried out in the usual method, the shovel delivering the excavated material into narrow-gauge industrial railway cars and transporting it to a suitable dump or location requiring filling.

Following the steam shovel came the drag line excavator and the backfilling apparatus shown in the picture.

The drag line machine would start excavating from a point where the boom could be used to its maximum capacity. Then remaining in this one position, it would continue to dig out the full amount of dirt required for the installation of the sewer.

After a suitable length of ditch had been obtained, approximately 50 ft., the work of putting in the sewer commenced, and from this time on a comparatively continuous cycle of operation was carried out. The drag line machine would dig as fast and as hard as the operator could make the machine go.

From the one position the bucket would swing back and forth from the excavation to the hopper, which is located at the end of the backfilling machine. Because of the reach of the boom, the drag line excavator could stand in this one position for several hours.

Regardless of the material or of the size of the lumps handled, the operator would dump his load into the receiving hopper, which was about 10x12 ft. long. The top of this hopper was made of heavy steel. Along the bottom was an endless feeder made of heavy steel overlapping pans, carried on two strands of heavy roller chain, which fed the clay at a speed of about 15 ft. per minute from the bottom of the hopper through a system of rotary knives.

These rotary knives or disintegrators took lumps 2 ft. or 3 ft. square and 4 ft. long, and reduced them to a size easily handled by the belt conveyor, which ran back from the feeder parallel to the excavation. This belt conveyor was rather an unique equipment, in that it was mounted on a series of industrial railway cars, thus making the whole outfit portable.

This conveyor, which was 40 ins. wide and 150-ft. centers, carried the dirt down back of the point where the men were building the sewer to a point where the concrete had already set and was ready for backfilling. Here it discharged the material on to a cross-belt or boom, which carried and distributed the material out over the finished sewer.

This system does away with much handling and rehandling of material for backfilling, which is usually done at a high cost, but the greatest points of interest to contractors are the speed and continuity of operation of the various parts, and the fact that the entire operation can be carried on within the street lines.

Ordinarily the rate of progress in a sewer of this description would be about 15 ft. of finished sewer per day, while by use of one of these machines no trouble was found, it is claimed, in getting from 30 to 35 ft. per day.

The mechanism is a comparatively simple one and is constructed throughout of heavy equipment built to withstand the shocks, rough usage and ordinary abuses found in all contracting work of this character. The entire equipment worked out in a satisfactory manner.

The Prince of Denmark on Catchbasin vs. Inlet

(As reported to M. E. by G. A. C., Pawtucket, R. I.)

Catchbasin or inlet—that is the question:
Whether 'tis better for the mind to favor
The building, care and maintenance of basins,
Or to take up arms against this sea of troubles,
And just build gutter-inlets. To dare to clean
No more, and, by that act, to say we end
The nuisance and the many natural shocks
These basins give us. 'Tis a consummation
Devoutly to be wished. To act, to sleep—
To sleep, perchance to dream. Ay! there's the rub!
For in that peaceful sleep what dreams may come,
After we have filled all those old basins,
Must give us pause. This is the thought
That makes us hesitate in building inlets;
For who would bear the gibes and jeers of man
Caused through mistake, the proud man's contumely,
The pangs of anxious doubt, results delayed,
The politician's keen, exhaustive search?
That, patient, bides such opportunity,
When he himself might his contentment have
By simply building basins.

Performance Data on Auto Eductor for Cleaning Sewer Catch Basins

Some very creditable records have been made by the Otterson Auto Eductor, here illustrated, in cleaning sewer catch basins. The truck with eductor and all attachments is built by the Kelly-Springfield Motor Truck Co.

The eductor consists of a 4-in. telescopic pipe, with a horizontal discharge branch at the top. At its lower end is an elbow connected to a 3-in. pipe from which a hose is led to the discharge of a centrifugal pump. A 1-in. nozzle from the 3-in. pipe is led into the 4-in. pipe, where it is turned upward. The 14-in. centrifugal pump is mounted on the side of the truck frame and its suction is connected to the body of the truck. It is driven by a link-belt chain from a power takeoff attached to the driving shaft of the truck. The sprocket on this shaft runs idle normally and is engaged by means of a lever near

the driver's seat. A pressure gage enables the driver to regulate the motor to give the proper speed and pressure at the pump. The ratio of the sprockets is such that the required pressure of 40 to 50 lbs. is obtained at a low motor speed. The body of the truck is a watertight steel box. Its tail gate is hinged at the top and is made watertight by means of clamp bolts which press a rubber gasket against the end frame. An opening in the bottom provides for the attachment of the inlet valve on the pump suction, and an opening in the side provides for the overflow valve. Within the body is a frame carrying transverse hinged baffle plates, and having a longitudinal partition plate extending the full length of the body. The 8½in. space between this partition and the side of the truck is called the clear-water compartment. The first three baffles extend only to the partition and have openings in the upper portion so spaced as to cause the flow of water and refuse to travel far. By this means most of the solid matter settles before the flow reaches the end baffle. This last baffle plate extends the full width of the body and is pierced with ¾-in. holes. Thus the flow is screened as it passes out of the main part of the body and again as it enters the clear-water compartment, with which the pump is connected. Spacers hold the baffles in position when the tail gate is closed. The opening of this gate releases the spacers so that the baffles can swing back and give free discharge to the contents as the body is dumped.

The machine can be converted into an ordinary truck for handling stone, gravel and other material. For this purpose the bottom is made of heavy plate, the baffle frame is removable and the two valve openings can be closed by bolted covers. In starting its work the truck, with body partly filled with water, is run close to the catch basin. The eductor arm is loosened and run out to position over the manhole and then the telescopic pipe is lowered until it rests on the refuse in the catch basin. The pump is then started, drawing water from the truck body and discharging it into the 4-in. pipe through the 1-in. nozzle at 40 to 50-lbs. pressure. This upward jet causes the refuse to flow into the pipe, where it is carried up and discharged into the truck. There the solid matter settles and the water comes back through the clear-water compartment to the pump.

George E. McCrath, Superintendent of the Bureau of Sewers, Chicago, reports the work performed by the Auto Eductor for the months August, September and October, 1917, as follows:

Cost of Operation

One chauffeur, 3 months at $115 per month	$345.00
One laborer in charge of auto crew, 2 months at $3.60 per day	176.78
One laborer in charge of auto crew, 1 month at $4.60 per day	112.95
One laborer in charge of auto crew, 3 months at $3.30 per day	243.08
Total for labor	$877.81
Repairs, gasoline, oil, etc	$308.08
Interest at 4% on $7,000 (cost of Eductor)	70.00
Depreciation at 10 cts. per mile for 1,380 miles	138.00
Grand total	$1,393.89

Work Performed

Number of miles traversed	1,380
Number of catch basins cleaned	1,073 at $1.299
Number of cubic yards removed	1,763 at .79

The average cost for cleaning catch basins during the past four years was $3.24 each. Using this price for comparative purposes it appears that the city has saved $2,082.63 upon the work performed by the Auto Eductor during the three months of operation.

In March, 1918, Chicago purchased six more of these machines; this increase in equipment is the result of the above record of performance.

During the first six days one of these machines was operated in Louisville, Ky., by a driver and two laborers unfamiliar with it, it cleaned basins at an average cost of 69 cts. each as compared with $3.40 by hand. The sanitary advan-

VIEW OF AUTO EDUCTOR EQUIPMENT FOR CLEANING SEWER CATCH BASINS.

tages of the machine were equally superior to the results secured by hand methods. During these days, in freezing weather, an average of 25 basins were cleaned in 9 hours. This figure, it was expected, would be increased to 75 after the first thorough cleaning.

At Portland, Ore., the performance of the machine was as follows:

Average number of basins cleaned per day	100
Average size of basins	1½x2x4 ft.
Wages of truck driver	$3.75
Wages of 2 laborers at $3	6.00
Total cost per day	$9.75
Average cost per basin	.10

At Indianapolis, Ind., time tests showed that the machine could clean a basin 9 ft. deep and 4½ ft. in diameter, full of heavy dirt and mud to the outlet of the basin, in 8 minutes.

Delivering Trucks Overland

Eastern distributors of "Schacht" worm drive trucks will not suffer any inconvenience on account of the existing railroad conditions. The G. A. Schacht Motor Truck Co. is shipping its trucks by rail to Pittsburgh, and its dealers in New York and eastern states are running them overland from Pittsburgh to destination. The company had at first decided to run the trucks overland from the factory to destination, but it seems the arrangement mentioned above will work out to the best advantage and keep all the dealers supplied with enough trucks for their requirements, which are increasing every month.

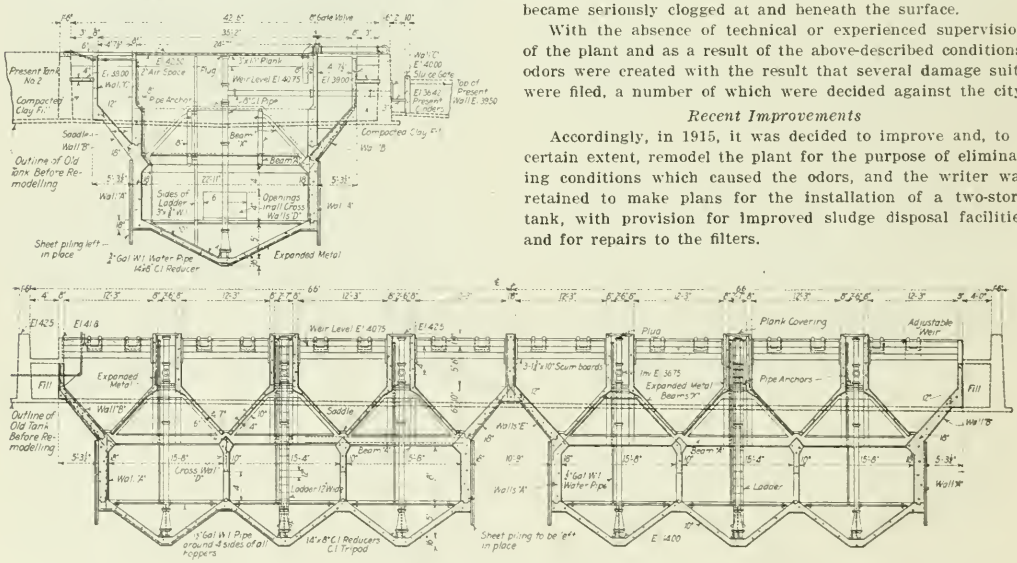
Water Purification and Sewage Treatment

Recent Improvements to Sewage Treatment Plant at Alliance, Ohio

By R. Winthrop Pratt, Consulting Engineer, 716 Hippodrome Building, Cleveland, O.

Alliance is a rapidly growing industrial city with a population of at least 25,000, located in the northeastern portion of Ohio on the main line of the Pennsylvania Railroad. The city is well supplied with modern public improvements, including a water supply, a water filtration plant and a fairly complete system of sewers, built on the separate plan. However, the roof water from many dwellings has been allowed to enter the sanitary sewers, so that the sewage flow has been found to vary from a minimum, during dry weather, of about 2,000,000 gals., to a maximum, during storms, of 5,000,000 gals. per 24 hours.

The Mahoning River, which flows through the northern part of the city, furnishes the water supply as well as the outlet for the treated sewage effluent from the city. This stream has a very low dry weather flow, so that thorough treatment of the sewage is necessary to prevent a nuisance.



TRANSVERSE AND LONGITUDINAL SECTIONS THROUGH SEDIMENTATION TANKS OF IMPROVED SEWAGE TREATMENT PLANT AT ALLIANCE, OHIO.

History of Sewage Treatment at Alliance

The first sewage disposal plant installed at Alliance was in 1893. This was one of the earliest plants in Ohio and was of the chemical precipitation or lime treatment type. This plant became outgrown and was unsatisfactory. It produced, in its overloaded condition, an effluent which caused a representative of the State Board of Health to report that "the lime treatment at Alliance does not measurably reduce the organic and polluting character of the crude sewage."

In 1913 there was placed in operation, at a different site, a new plant comprising grit and screen chambers, three single-story open sedimentation tanks, 9.5 ft. deep; twelve 5-ft. contact beds of ¼-acre each, and four 1-acre intermittent filters, one of which was intended for a sludge drying bed. Locomotive cinders were used as a filtering medium. The contact beds were filled with the coarser cinders and the fine-grained filters with the screenings and very fine material.

Soon after starting certain operating troubles developed. These related chiefly to the removal of sludge from the sedimentation tanks, to the offensive condition of the sludge and to drying the sludge on the bed provided therefor. Also, there formed rapidly at times, on the surface of the liquid in the tanks, a thick scum or mat, which was more or less offensive; and, furthermore, by reason of the excessive wet weather flows in the sewers, this scum together with some of the deposited sludge, was swept out of the tanks and on to the contact beds. By reason of this, and also on account of the occasional presence of large amounts of suspended matter in the tank effluent, due to septic action in the tanks, the beds became seriously clogged at and beneath the surface.

With the absence of technical or experienced supervision of the plant and as a result of the above-described conditions, odors were created with the result that several damage suits were filed, a number of which were decided against the city.

Recent Improvements

Accordingly, in 1915, it was decided to improve and, to a certain extent, remodel the plant for the purpose of eliminating conditions which caused the odors, and the writer was retained to make plans for the installation of a two-story tank, with provision for improved sludge disposal facilities and for repairs to the filters.

The plan adopted for the improved plant included: (1) The conversion of one of the three sedimentation tanks into six two-story tanks of the Imhoff type, with minor changes in the other two tanks; (2) the construction of new glass-covered sludge beds within the area occupied by one of the fine-grained filters; (3) the construction of a new fine-grained filter and covering some of the others with a layer of sand; (4) the installation of ejector equipment for transferring the sludge which accumulates in the old sedimentation tanks into the sludge digestion compartments of the Imhoff tanks, and thence, after digestion, onto the new sludge beds; (5) improving the contact beds partly by washing and replacing the cinders and partly by replacing the cinders with slag; and (6) miscellaneous minor improvements. During the entire con-

struction work, which occupied about twelve months, the sewage was allowed to flow through at least one of the sedimentation tanks. The work was divided into three contracts, as follows:

Contract No. 1—Remodeling of tanks and installation of pumping and ejector machinery.

Contract No. 2—Washing and replacing filtering material and miscellaneous minor improvements.

Contract No. 3—Glass-covered sludge beds.

Tanks

After deciding to install a two-story tank, a type which had come into use since the original design of the plant, the question came up as to how the existing tanks could be used to the best advantage. These tanks, which had a total capacity of 1,000,000 gals., equivalent to 8 hours on the nominal flow of 3,000,000 gals. per day, afforded an excellent means of clarifying the sewage as long as there was no marked septic action.

The best solution seemed to be a plan whereby two of the tanks were retained as sedimentation basins, while the third was changed into a two-story tank having sufficient sludge storage capacity to digest sludge which would be produced by all of the sewage treated, thus retaining the advantages of the old tanks as regards sedimentation, but an improved means of removing, digesting and disposing of the sludge from these tanks. The flow chamber capacity of the new tanks was made simply large enough to treat about 50 per cent of the total flow on the basis of two hours' sedimentation.

The sewage flow would be split about equally between the new tanks and one of the old ones, while the other old tank would be standing empty or being cleaned. This tank will serve, furthermore, to take the excessive flows which occur during wet weather on account of down-spout connections and leaky sewers, thus preventing excessive rates through the tanks handling the dry-weather flow.

When the sludge deposited in the old tanks begins to become septic and interfere with sedimentation, it is the plan to drain the supernatant liquid—that is, the upper nine-tenths of the tank—out onto one of the fine-grained or low-level filters, and to pump the sludge by means of an ejector into the digestion chamber of the two-story tanks. During this operation, of course, the sewage flow through that section of the tank receiving the sludge will be cut off.

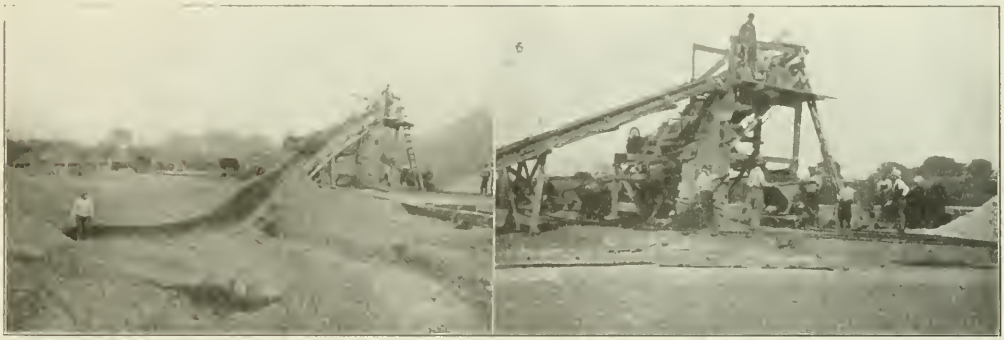
In the sedimentation tank which was remodeled, most of the bottom was cut out and a group of six two-story tanks built entirely inside as a separate structure and to a total depth of 28.5 ft., or 18.5 ft. deeper than the original tank. The feature in this construction was, of course, the care required to prevent the undermining and settling of the existing walls. The design of the new tanks took this into consideration. The earth was retained by driving a double row of wood sheet piling 8 to 9 ft. distant from the inside of the existing walls, which piling was left in place and used as a form for the walls of the sludge compartment. The material was a rather wet clay, and the method used was entirely successful. The tanks were also designed so that the flow compartment walls securely braced the walls.

Another feature was the utilization of the existing walls of the old tank as walls for the new flow channels.

A 200-gal. per minute air ejector was placed in a separate chamber constructed in one of the contact beds adjacent to the tanks, for the purpose of raising the sludge from the old tanks into the digestion chamber of the new. On account of the depth of the new tanks it was also necessary to lift the sludge to the sludge filters, and this was likewise done by means of an air ejector having a capacity of 100 gals. per minute.

Contact Beds

Preliminary studies were made to determine the location and extent of clogging in all of the beds. Each bed was filled with sewage, the volume of sewage required being carefully measured in order to determine the percentage of voids. The time required to empty the bed was then noted, by taking measurements of the level of the water every half hour. Also, pits were excavated in the material at various points to observe the character of the clogged material. The cinder filtering material in the bottom of several of the contact beds was found to be so badly clogged that it was considered necessary to remove it.



VIEWS OF PLANT FOR WASHING AND SCREENING DIRTY CINDERS FOR SEWAGE BEDS, ALLIANCE, OHIO.
Dirty Cinders Hoisted Over Runway in Slip Scraper to Elevated Platform, Dumped into Screen, Washed While Screening, Discharged into Industrial Cars and Transported Back to Beds.

There were estimated, by means of the above observations, the approximate quantities of material to be removed and either discarded, or screened or washed and returned to the beds. The treatment necessary was, of course, varied as the beds were excavated and the actual condition of the bulk of the material more readily observed. It was found on completion, however, that the preliminary estimates were ample to cover the amounts of material which had to be handled.

Incidentally, it is interesting to note that the condition of the beds as regards freedom from clogging was found to improve during the several months of rest period given some of the beds while the work was under way, due to the drying and disintegration of the sludge. However, it was found that where the clogging had been greatest the cinders contained much dust and fine material, which would have caused further clogging after again receiving the sewage.

Washing and Replacing Cinders

An interesting feature of the construction was the method employed for removing, washing and screening and returning the cinders to the beds. This process is shown by the accompanying photographs. The dirty cinders were transferred di-

rectly to an elevated platform over the screen by means of a scraper, runway and hoist, and were dumped directly into the screen, which was of the horizontal, cylindrical type, with ⅜-in. openings, having a water pipe extending along its axis. The water pipe, which was perforated, played the water on the cinders in sufficient quantity thoroughly to wash them before they left the screen. The washed and screened cinders were discharged into industrial cars and thence transported back to the beds.

The new material for the contact beds consisted of ¾ to 1½-in. slag for the main portion of the beds and ½ to 1-in. gravel for placing around the distribution pipes. This material was transported from the railroad siding, about 1,800 ft. distant from the plant, by means of industrial cars loaded from bins at the siding, and was dumped directly into the beds, the industrial tracking being carried onto the beds along the concrete dividing walls.

Of distinct interest from a practical standpoint was the method of taking bids and awarding the contract for this covering. Instead of designing the structure in detail before inviting bids, several reputable greenhouse companies were invited to submit plans and specifications for their standard types of construction. From these a general type of construction was decided on and plans and specifications prepared and made sufficiently general to permit competitive bids based on standard construction. This undoubtedly saved considerable money for the city, because it permitted, within limits, the use of the standard lengths and sizes of the successful bidder. The plan also tended to secure highly skilled and experienced workmen.

The glass covering comprised a rigid steel framework and wood sash, the latter hinged at the top and connected to operating apparatus arranged for opening and closing all of the sash from central points on the walls of the sludge beds.

VIEWS OF GLASS COVERING OF GREEN-HOUSE TYPE OVER SEWAGE SLUDGE BEDS, ALLIANCE, OHIO.
Rigid Steel Framework and Wood Sash Hinged at Top and Connected to Operating Apparatus.

Secondary Filters

To improve the secondary or fine-grained filters, which were composed of cinders, it was found necessary only to remove about 4 in. of cinders from the surface of the beds and to replace this material with clean, coarse sand. Two of the fine-grained beds were improved in this way. The sand was transported and placed in the same manner as the slag and gravel. Also, to provide additional filtering area, a new fine-grained filter of similar material was constructed in the space originally planned, but not previously utilized for this purpose.

Sludge Beds

It was decided to utilize for the construction of the new sludge bed a part of the fine-grained filter formerly used for drying sludge. Accordingly, 12 in. of the dirty cinders were removed from the top of this filter, concrete curb and dividing walls constructed, extending through the cinders to solid ground, and 9 in. of clean sand and 3 in. of gravel placed over an area of ¼ acre. Industrial tracks for the removal of dried sludge were placed along the center line of the beds and extended on the outside at both ends, the length of the original filter. That portion of the old filter not occupied by the new sludge bed is still available for sludge drying.

Glass Covering

The sludge beds were provided with glass covering of the greenhouse type of construction. This was done for aesthetic reasons, as well as for the practical reasons of preventing the possible spread of odors from improperly digested sludge and of permitting the drying of sludge to continue in all kinds of weather.

Personnel

The improved sewage treatment plant was designed and constructed under the direct supervision of the writer, with the assistance of R. F. MacDowell and R. E. Garvin. H. H. Hampton, H. A. Cooke and R. J. Auld, Jr., were inspectors. Contract No. 1, for the tanks, was awarded to the Henderson Construction Company, of Youngstown; Contract No. 2, for the contact beds, to Homberger & Wagar, of Sandusky, and Contract No. 3, for the glass covering, to the King Construction Company, of North Tonawanda, N. Y.

The Ozone Method of Water Treatment and Some Examples of Recently Installed Industrial Plants

By Irwin D. Croak, Consulting Engineer, Monadnock Block, Chicago

The oldest method known for water purification is by storage. A body of water kept in basins from 10 to 30 days is affected by sunlight. The bacteria are reduced considerably and the matters in suspension settle to the bottom of the basin. Naturally, unless the basin is cleaned regularly, the effectiveness of this crude method is reduced.

Characteristics of Other Processes

Sedimentation, assisted by chemical coagulation, is effective. The objection to this method is the large initial expense and upkeep of the grounds and buildings, and that some of the chemicals will remain as a residue in the water, leaving taste and some odor. It is interesting to know that there is not a single sedimentation plant which is better than 98 per cent. efficient. Some of the harmful bacteria will get through.

Slow sand filtration is one of the natural methods for getting clear water. It does not kill all the bacteria, but takes out the matter in suspension. Old filters become inefficient and need cleaning. They require a large acreage, and if they

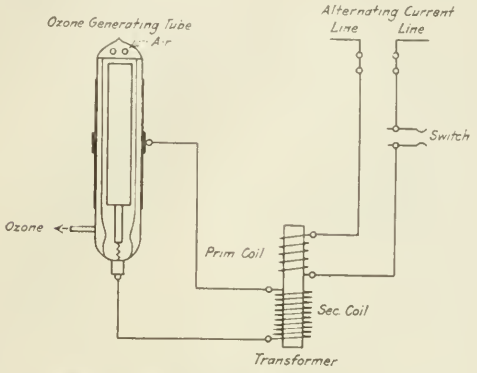


FIG. 1—DIAGRAM OF EFFICIENT AND INEXPENSIVE OZONE GENERATOR.

are not covered they will freeze in winter. While they take out a good deal of the impurities, the water is not absolutely safe for drinking.

Mechanical filtration is a more modern method than slow sand filtration. It does the work in less time and in less space, but is not absolutely safe by itself, and can be considered only as a part of water purification.

Chlorine and hypochlorites are good germicides. They do kill the germs. Objectionable features to their use are that they have a taste and odor, and overdosing may become dangerous for the human system. There is a chance of the water giving rise to a dark color, as organic matters form compounds, with especially disagreeable odors and tastes. Also, it is proven that there is an aftergrowth of bacteria in the tap water in many cases.

The methods of sterilization include distillation, which can be done only on a small scale, but this takes out the mineral qualities of the water and we get only H_2O. Boiling the water can be done only on a small scale. The boiled water is flat. The impurities, both organic and inorganic, and the matters in suspension, remain in the water; also, the killed bacteria. This is merely a makeshift for the household.

The ultra-violet-ray method of sterilization is effective, provided the water is carefully filtered and the lamps are made right and the water flows around the lamps without any shadow being created. It does not remove organic matter, bad odors or taste of chlorine.

The method which has stood the test is the treating of water with ozone.

Development of the Ozone Process

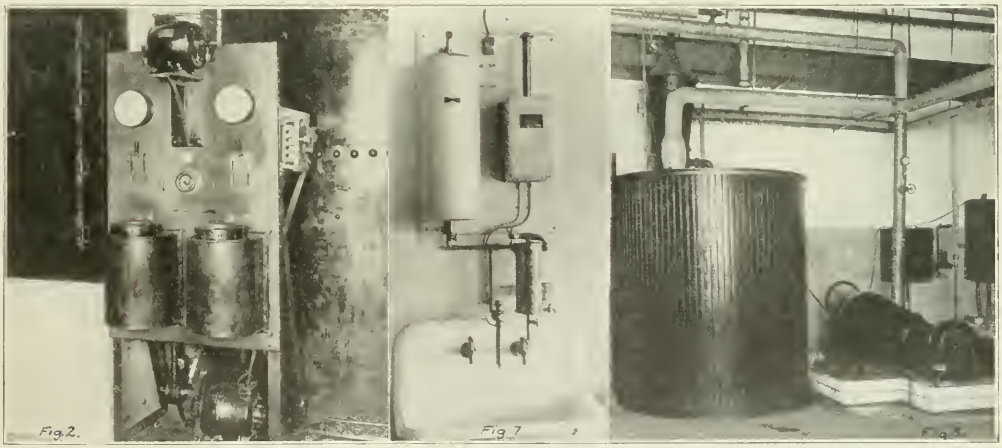
Ozone is the strong, powerful gas, O_3. For water purification it was used first by Schoenbein in about 1849. The project was taken up on a commercial scale by Siemens & Halske in 1898, and in a short time thereafter a number of plants were installed in Europe, and today about 60 or 70 large municipal plants are using the ozone method of water purification, in Germany, France, Italy, Russia, Roumania, and even in South America.

The first plant was in Paderborn, Germany, where typhoid fever has entirely disappeared from the town. Petrograd, Russia, and Munich, Germany, use ozone for large breweries and industrial plants, and Astrachan for sterilizing mineral water. In France alone, in 1915, there were 26 plants working, including that of Paris. Besides Siemens & Halske, Tindal, whose patents passed into the hands of M. de Frise, who improved on them, also Otto, and several others worked and made improvements. Vosmaer spent about 15 years of scientific study on the use of ozone for water purification and other industries.

The application of ozone in water treatment depends on the properties of the water itself. It is preferable to use rough filtration in order to make the water clear of matters in suspension. It makes quite a difference for the designer of a plant whether he has to contend with river water, lake or well supply. Ozone itself, if properly handled, will reduce the turbidity due to organic matters about 70 per cent., but it is cheaper to do that with rough filtration, and let the ozone act on the bacteria and organic impurities.

Nature of the Process

How does ozone act on the water? Just as in nature. Both before and after a rain we smell ozone; the air is charged with it. The rainwater comes in drops; every part of it is touched by the ozonated air.



VIEWS OF THREE TYPES OF OZONE PLANTS FOR TREATING INDUSTRIAL WATER SUPPLIES.
Left to Right: Fig. 2—Part of Installation Used for Six Years in C. B. & Q. Ry. Office Building in Chicago. Fig. 7—Type Used in Residences and Small Factories. Fig. 3—Another View of Same Installation Shown in Fig. 2.

Science has put into commercial form the imitation of this occurrence. We all know that through either seepage, vegetation or sewage contamination, there is hardly any water which is not contaminated with harmful bacteria. Ozone mixed with this water will discharge one part of oxygen in so-called status nascendi. This part of oxygen makes a combination with the

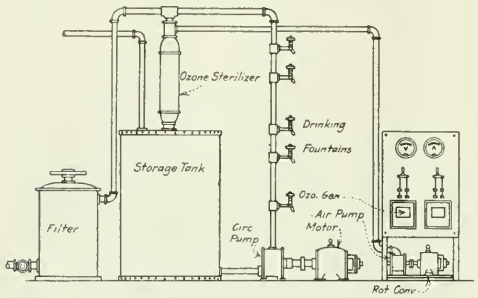


FIG. 4—OZONE PLANT INSTALLED AT PHOENIX KNITTING WORKS, MILWAUKEE.

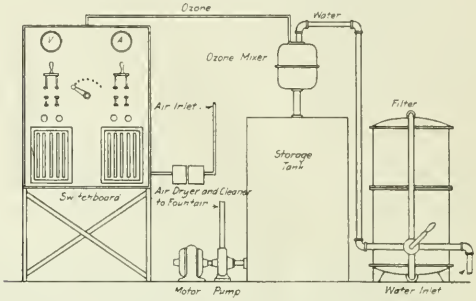


FIG. 5—OZONE INSTALLATION FOR SCHOOLS, PUBLIC BUILDINGS AND SMALL INDUSTRIES.

carbon of the organic impurities, burning them up into CO_2, and literally removes the harmful and odor bacteria from the water and produces not only a safe, but palatable, crystal clear, oxygenated water.

Naturally it took some time before a process was worked out on a commercial scale in such a way that now it is possible to produce and to manufacture an apparatus for a reasonable amount and small upkeep. The most important part of the equipment is the ozone generator. The Electric Ozone Sterilizer Company, of Chicago, claims to have an efficient and inexpensive ozone generator, consisting of a vacuum tube, which is made from glass—see Fig. 1. Around this vacuum tube there is another glass with metal contact. About 5,500 volts or more of alternating current, in passing through there, produces a silent discharge of electricity. The proper name is brush discharge; sparking would produce nitrites, which are harmful. This brush discharge makes ozone from air. Conveying this ozonated air into the mixing chamber or sterilizing towers is another secret of reproducing nature's own water purification.

It is not only important to have pure ozone and have a simple device for making the ozone, but equally as necessary to have an efficient mixing device to use up every particle of the ozone and to make sure that all molecules of the water shall be thoroughly mixed and in touch for at least a short period, by passing the water through the mixing or sterilizing chamber. The air should be filtered and dried before entering the ozone generator. The ozone exercises a selective action. First it destroys the pathogenic, less resistant bacteria. On a commercial scale it is not advisable to go too far with the process. To give an idea of how much ozone is required to treat the water, anywhere from one-half to three grams per cubic meter of air is the general method for concentration. Regarding the output of ozone per horse-power employed, 25 to 30 grams, sometimes even up to as high as 35 grams, is an average for rate of production.

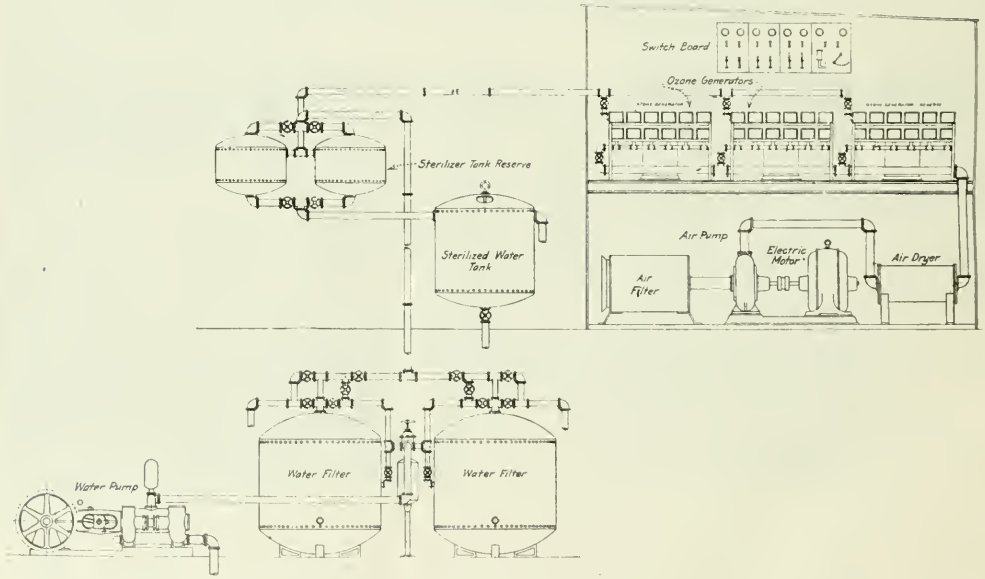


FIG. 6—OZONE WATER PURIFICATION PLANT OF LARGE SIZE, SUITABLE FOR USES OF CITIES AND LARGE INDUSTRIAL PLANTS.

If the air is cooled the results are better than with warm air. On large installations it is advisable to use a refrigerator. The above amount of ozone per hour, according to the contents of the water, is enough to sterilize from 400 to 1,800 gals. of water.

The Process as Viewed by European Authorities.

Quoting from Don & Chisholm, of "Modern Methods of Water Purification," pages 202-3, they say: "Naturally, a purification process which converts an unwholesome stream into a liquid as certainly inoffensive as the purest spring water is one that appeals directly to water undertakers. * * * The consumer cannot find fault with the treatment, for no residue of the purifying agent is left in the tap water. * * * It is an ideal procedure."

With reference to the treatment of river water, we are quoting the following: "The results obtained were upon the roughly filtered Marne water. The latter carries at times as many as 300 bacteria per c.c., and B. Coli is discoverable in 40 c.c. The color of the water is dull, with a brown to greenish hue. The water that comes from the sterilizer is bright and sparkling, and highly transparent. The perceptible odor at the sterilizer is almost entirely vanished before it is ready to flow away from the last compartment. There is no increase in nitrates in the ozonized water as compared with the filtered water, nor are there any nitrites, chlorine compounds, or any peroxide of hydrogen traceable to the electric discharge. These are the conclusions drawn by Drs. Ogier and Bonjean (1904) and by Dr. Rideal (1908)."

In some plants water contains over 4,000 bacteria per c.c. and is made safe with ozone treatment.

"In Ginnekin, Holland, the ozone treatment reverses the vitiated condition of the water, and produces an effluent which is not only to all intents sterile, but is clear, sparkling, and, to use the description of Professor Gerard, appetizing. It has acquired all the properties of the best upland water, which is only distinguishable to the chemist."

Some Representative Installations

Fig. 2 shows an installation which has been working for about six years at the Chicago, Burlington & Quincy Railroad 17-story office building, in Chicago. It is in the second basement of the building, in the power plant. The equipment consists of a switchboard, with two sets of ozone generators, consisting of ten tubes each. On the top of the switchboard there is a rotary converter direct to alternating current. At the bottom of the panel there is an air dryer and air pump. The air pump, which blows the air through the tubes into the ozone sterilizer water chamber, is shown in Fig. 3, on the top of the tank. The tank itself is white enameled inside and has refrigerating coils on the outside, and is well insulated to keep it cooled.

From this tank the water is piped throughout the building and circulated to every bubbling fountain for 2,500 employes and about 500 to 600 other people who come and go in the building. The capacity of this plant is about 800 gals. an hour. The water, before it comes to the sterilizer, goes through a sand filter, also a paper filter.

Fig. 4 shows a recent installation at the Phoenix Knitting Works, Milwaukee, Wis. Fig. 5 shows an installation for schools, public buildings, and bottlers of carbonated beverages. Flynn & Co., in Quincy, Ill., have had an outfit in use for five or six years, of about 700 gals. per hour capacity. Fig. 6 is a municipal or large industrial plant. Fig. 7 is for use in residences and small factories. The Chicago Box Company have used it successfully for years for their office and about 90 employes in their factory. There are over a hundred of these in Chicago alone. Besides municipal, industrial, hospital and residential outfits, there is a distinct feature that the Electric Ozone Sterilizer Company is in position to design and build: a special portable outfit for expeditions, contractors, builders, and for soldiers while in the barracks and in the field. The German army was equipped with portable outfits long before 1912, also the Russian army and Japanese army were equipped with them as far back as the Russian-Japanese war.

The space required for the apparatus is very small. Each tube has a capacity of 30 to 200 gals. of water per hour; its electric consumption is about 2 watts. It merely means a duplication and many sets of tubes and mixing chambers for a larger plant. The results are positive, without any question or doubt as to the outcome. The process has proved itself in the last decade. It not only disposes of the bacteria, but takes out the odor and improves the taste of drinking water, without leaving any residue or chemicals in the tap water, and hardly changing the mineral content of the water.

Some Points Worth Considering in the Design of Sewage Treatment Works

By John H. Gregory, Consulting Engineer, 170 Broadway, New York City

In recent years a large number of sewage treatment works have been built, but it can hardly be said that all of the works have been satisfactory when judged from the operating as well as from other standpoints. In some cases fundamental errors have been made in the type of works adopted, but such instances are probably relatively few. The failure, then, of the works to fulfill expectations may be due either to neglect in the design of what many would call the minor details, to appreciation on the part of the designer as to how the works will operate, or to inefficient operation.

In this brief article it is intended to draw attention to some of the points, but by no means all, which may well be considered in the design and construction of such works, and which have been brought home to the writer not only as the result of many years' experience in designing sewage treatment works of various types, but also as the result of having visited and inspected a large number of works in this country and abroad.

General Arrangement and Accessibility

Careful consideration of the general arrangement of the works is time well spent and the arrangement should be studied not only from the standpoint of efficiency, but also convenience of operation. While the two points just mentioned may be of greatest importance, nevertheless, it is highly desirable to consider the general appearance of the proposed works as they would be viewed not only by the professional engineer, but by the casual observer.

A compact arrangement of the several parts of the works is desirable, but if too compact the finished works will look crowded. There must be elbow room, not only for convenience of maintenance and operation, but also for the sake of appearance. Again, if too compact an arrangement is adopted, it may be more or less difficult to arrange for future extensions or connections. The tendency is to build works ample for the present and for a few years to come, but not to build works of size sufficient to serve for a long period of years. Practice in sewage treatment has changed and probably will change more or less from time to time and while a works when built may be thoroughly up to date it may not be so some years later. In other words, an extension of the plant may involve a somewhat different method of treatment of the sewage, either in whole or in part, and, therefore, it is desirable that the arrangement of the works be not too compact so as to permit of readily making connections to the works in the future at several points should occasion so demand.

Reference may now be made to some features more or less common to many treatment works as illustrating to a certain extent the point of view to which the writer wishes to call attention.

Grit Chambers

The function of a grit chamber, as the name may imply, is to remove grit, rather than organic matter, but we may well ask, have all of the grit chambers which have been built satisfactorily fulfilled the above requirement? If not, the velocity through the chamber may have been so high as to carry a very considerable portion of the grit through the chamber, or else it may have been so retarded as to cause an appreciable deposition of organic matter. It is possible to design a grit chamber which will operate satisfactorily, but it cannot be done by making one or two rough computations and assuming that the result thereby reached is good enough.

For example, not only must the present, but also the future rate of sewage flow be considered, as well as the hourly and daily variations in rate of flow. Another feature, which must be carefully considered, is the shape and section of the approach. It is obvious that the sewage should enter the chamber with as little eddy action as possible and without cross currents. A grit chamber is not a long structure and failure to provide a suitable approach may interfere very materially with its efficiency in operation.

If a grit chamber serves the purpose for which it is designed, grit will be deposited and must be removed from time to time as occasion demands. Such being the case, provision should be made, in designing the works, for easily removing the grit, and if in order to do this the chamber must be unwatered, means should be provided so that this can be quickly and easily done.

And after the grit has been removed from the chamber it must be disposed of somewhere. If it is inoffensive it can be readily used for filling, but if offensive it should be buried, or first washed if it is to be used for filling. It certainly does not want to be left lying around anywhere and everywhere at the works as is sometimes the case. Such a method of disposal would be likely to cause the visitor to go away with the idea, and perhaps rightly, that the works were carelessly operated.

Screens

Screens, in some form or other, are generally needed at a sewage treatment works, the fineness of the screens being dependent on the results desired, but if screens are used they must be cleaned and the screenings removed. The frequency of cleaning depends largely on the fineness of the screens, but also on the character of the sewage. Screening is generally the first step in the treatment of sewage at a works and is forever with the operator whenever the works are in operation. Too much thought cannot be given to screen design, not only from the standpoint of the removal of floating and suspended matter, but also from the standpoint of convenience of operation. This means that not only must the screen itself be so designed that it can be easily and readily cleaned, but also that the arrangement of the structure around the screen must be such that all parts of the screen are easily accessible to the operator, and a suitable platform or platforms must be provided from which he can work. Attention to small details here are vital, and yet how often have they been neglected or overlooked.

Screenings accumulate, not only daily, but hourly. With a very coarse screen they may be inoffensive, whereas with a finer screen they are likely to be offensive, and with a fine screen still more offensive. In other words, the finer the screen the greater the amount of screenings removed and the more offensive they become. Screenings containing much organic matter, especially that which is easily putrescible, *must* be removed and disposed of promptly or else a nuisance is almost sure to result. And yet the disposal of the screenings is often overlooked. It is not the intention to discuss here the means of disposing of the screenings, but the writer does desire to emphasize the necessity of prompt disposal, and by disposal he does not mean simply taking the screenings to a nearby point and there storing or dumping them.

The actual purification secured by screens, even fine screens, is small, very small, notwithstanding that the material removed, especially by fine screens, is very offensive and putrescible. And in considering whether or not to adopt fine screens the fact should by no means be overlooked that their adoption means the continual disposal above water of a small but extremely offensive material, and that the nuisance caused by an improperly operated fine screening plant may be put on a par with that caused by improperly operated sewage treatment works of other types.

Open Channels

Open channels in and about a sewage treatment works are, in general, preferable to covered conduits. They are much easier to clean and inspect. It is not always possible, however, to provide open channels, but when used they should be of substantial construction, not the flimsy construction which may be seen at times. It seems hardly necessary to say that self-cleansing velocities should be used, but many instances can be cited where this point has been entirely overlooked. If it becomes necessary, as sometimes is the case, to use low velocities, then the adoption of open channels is especially desirable, as they can be much more readily kept clean than can covered conduits.

Tool House

A tool house, or store house of some kind, even if small, is almost a necessity, and yet how often has it been omitted with works which have been built. In some works which the writer has visited it seems almost as if the fact that sewage was to go through the works had been entirely overlooked and that tools of one kind or another had to be used. A tool house is not an expensive luxury and is always appreciated by the operator. It may be that but few tools will be required and that but very simple records of operation must be kept, but if a tool house is provided a place is then available for the putting away of tools, as well as small stores and supplies and for the keeping of records.

Closure

In the foregoing perhaps enough has been said to call attention to the necessity of giving careful consideration to all of the details of a sewage treatment works, and especially to what some might call the minor details. It is often that attention given to just these minor details will be the difference between success and failure.

In studying the design of a sewage treatment works, and especially convenience of operation, one cannot do better than to place himself in the position of the operator and study the design from the standpoint of the operator, commencing at the point where the sewage enters the works and ending with the disposition of the effluent as well as that of all of the material removed in the various steps of the process. If this will only be done, before a design is completed and the works built, much good may result from such a study.

In closing, attention should be called to one other point, and in the opinion of the writer a most important one, namely the aesthetic treatment of the works. And yet how little attention, especially in this country, has been paid to this phase of the subject. It doesn't cost much more to trim up the exposed parts of the structures in a neat manner than to omit such trimming. The tops of walls can be finished with copings at a very slight increased expense, with the result that the structures have a finished appearance, and yet how many instances can be cited where walls have not been so treated and have been left with ragged and chipped edges and out of line.

Again, it doesn't cost very much to provide gravel walks around a works, especially so that all operating points are readily accessible. And yet, have such walks generally been provided?

Still further, it doesn't cost much to provide a little planting and flowering shrubs and hedges. And yet, how often are they to be seen at a sewage treatment works?

Is is not worth while to pay more attention to some of the points considered herein as well as to others of a similar nature?

DRAINAGE AND IRRIGATION

The Outlook for Land Drainage for the Year 1918

By A. H. Beitman, of Edmund T. Perkins Co., 317 Illinois State Bank Bldg., Quincy, Ill.

With the growing demand for food, the question of producing, from every acre of tillable land, the greatest possible crop has become a necessity. Scientific farming is daily assuming greater importance, but as yet drainage, a fundamental requirement, has not received the attention which it merits. In fact, construction work on drainage projects has been retarded for lack of equipment, material, supplies and labor, and unless those in charge of drainage projects bestir themselves to obtain the desired assistance from the Federal government, the outlook for drainage for 1918, and probably for the next ten years after the war will be dismal.

Public Sentiment Must Be Aroused

The drainage situation is in fact very alarming. The several bureaus of the Federal government, overburdened with other work, have little time to investigate industries which are not immediately concerned with war activities, and it is only by proper presentation of the facts that an industry which is an essential factor in food production will receive assistance. No one is better qualified to know these facts than those engineers who have failed to obtain priority rights from the Priorities Division of the War Industries Board, or been unable to obtain from the capital issues committee authority for needed bond issues. The public at large has not realized the importance of drainage as a requirement for greater food production, nor as an economic factor in the development of the country, and unless public sentiment is aroused and made to see its importance, the desired results will not be forthcoming.

Extent of Unproductive Land

According to the 1910 census there were 478,000,000 acres of improved lands in farms in the United States. The Department of Agriculture has estimated that of this area, approximately 150,000,000 acres are producing only 20% as much as they should on account of insufficient drainage. In addition to this area there are in the United States about 80,000,000 acres of swamp and overflowed land at present unproductive, unhealthy and a menace to the people of the United States.

With a small expenditure of money and time, a large part of this land could be reclaimed and made a garden spot.

Progress of Reclamation of Waste Lands

Thus millions of acres in this country are curtailed in their productiveness on account of surplus water and frequent floods throughout the growing season. The progress that is being made to reclaim these waste areas is very unsatisfactory. A request for information as to the present status of the work and its effect upon the present situation was sent out recently in the following form:

TABLE I
Report

Cypress Creek Drainage District, Desha and Chicot Counties, State of Arkansas. S. W. Whitthorne, engineer.

Commissioners: Dr. Vernon MacCammon, Arkansas City, Ark.; Gus Waterman, Dumas, Ark.; T. D. Newton, Sr., Winchester, Ark.; E. G. Newlin, Watson, Ark.; Ed Warrington, McArthur, Ark. Office address, Arkansas City, Ark.

No.	Question	Answer
1.	Acres in district?	289,000
2.	Approximate acres in cultivation?	31,000
3.	Crops jeopardized in 1918 if improvement stops?	26,500
4.	Acres to be in cultivation in 1918?	33,000
5.	Probable number of acres to be in cultivation in 1919?	38,000
6.	Total cost of reclamation?	$1,000,000
7.	Per cent completed?	42%
8.	When will work be finished?	Dec., 1919
9.	*Coal necessary for the completion of this work?	6,000 tons
10.	Wire rope necessary for the completion of work (rope given equivalent to 1-in. W. R.)	40,000 ft.
11.	Amount of repairs (iron and steel castings, structural and bar steel, cast and sheet brass, pipe and fittings)?	$21,000
12.	Number of skilled laborers required to operate the machines on this work?	30 men
13.	†Number of unskilled?	35 men
14.	Number of men who are in Class 1 of the draft?	2 men
15.	Amount of oil needed to finish this work?	300 bbls.
16.	Average corn crop per acre?	35 bu.
17.	Average cotton crop per acre?	235 lbs.

*Only one plant out of five is using coal. Balance use wood cut off of right of way.

†About 30 additional colored hands are used in cutting wood and clearing right of way, when not engaged as farm hands on local plantations.

Conditions in 87 Important Drainage Districts

Replies were received from 87 drainage districts, showing the results given in Table II.

TABLE II

States	No. of D. D.	Acres	Cost	Acres Cultivated In 1918	Acres Cultivated In 1919
Arkansas	17	991,000	$5,860,000	328,000	449,000
Florida	3	217,000	325,000	1,000	3,000
Illinois	6	163,000	8,294,000	54,000	78,000
Indiana	3	1,003,000	374,000	48,000	144,000
Iowa	20	587,000	5,220,000	342,000	417,000
Kentucky	1	55,000	624,000	41,000	50,000
Louisiana	1	3,000	100,000	2,000	3,000
Minnesota	4	963,000	589,000	22,000	66,000
Missouri	13	769,000	8,383,000	401,000	554,000
Mississippi	6	155,000	1,156,000	71,000	146,000
Nebraska	2	7,000	76,000	5,000	6,000
Tennessee	10	135,000	1,135,000	35,000	59,000
Wisconsin	1	2,000	10,000	1,000	2,000
South Atl'tic states.		52,000	650,000	18,000	22,000
Total	87	5,132,000	$32,796,000	1,369,000	1,999,000

Rate of Reclamation of Swamp Land

This shows that the progress of reclamation of swamp and overflowed land is at the rate of about 1,500,000 acres per year, and at that rate it will take 53 years to reclaim all swamp and overflowed lands in the United States. The progress in tiling farms is still slower and, according to reliable estimates, it will take 180 years at the present rate of progress to make 100% productive the 150,000,000 acres of tillable land, which are producing now only 20% as much as they should on account of insufficient drainage.

According to the 1910 census, the tillable area per person in the United States was 53 acres. Should we maintain this ratio it would mean that with an increase of 2,000,000 population per year the tillable area in the United States should increase at the rate of 106,000,000 acres per year. It is true that a much smaller area than 53 acres will be capable of sustaining a person, but, notwithstanding, with the increase in population, it becomes necessary that we also increase considerably the productiveness of every acre, and especially the tillable area in the United States unless we would find ourselves in years of small crop production in the same situation as we are now.

Existing Conditions in Detail

Since drainage is primarily an engineering problem, it behooves every engineer to take a stand with definite and distinct demands for the protection of this great industry by the

various departments at Washington, and arrange for a continued active watching and safeguarding of their interests and the public. In detail the following are the existing conditions:

(1) Finance—To finance drainage work it will be necessary to submit proposed issues of bonds to the Capital Issues Committee. The application will be referred by this committee to the Bureau of Drainage Investigations for recommendation and only those projects which are in a large percentage completed or which promise immediate results will be approved, as immediate food production for the war is the deciding factor.

(2) Fuel—The Fuel Administration is positive in the statement that the crisis in supplying fuel is past. When a drainage district cannot get the fuel for the contractor or for the pumping station furnished by local coal dealers, they can submit their contract to the Fuel Administration to the Department of Apportionment and Distribution, Domestic Industries, Washington, D. C., with the approval of the Department of Agriculture as to the necessity of material and assistance will be rendered in obtaining the necessary fuel.

(3) Transportation—With the approval of the Department of Agriculture, the Car Service Bureau, 1019 Interstate Commerce Building, Washington, D. C., will undertake to provide necessary cars, but this bureau takes the same positive stand as the Fuel Administration and insists that the crisis is now past and that there will be no difficulty in obtaining cars.

(4) Priority Certificates—The priority committee will issue priority rights if the request has endorsement of the Department of Agriculture. The Priority Division is also conducting through its Bureau of Investigation and Research, an investigation as to why the priority is requested and the necessity for it must be shown by establishing the fact as to how much sooner delivery will be made with the priority certificate than in the ordinary course of business. Then the fact having been established that a priority certificate is necessary and helpful, it will be issued.

How to Protect the Industry

It is, therefore, seen that for the protection of the industry, it is necessary to impress upon the Department of Agriculture the necessity of prompt and favorable decision, and aid this department in obtaining the necessary field force to make prompt investigations and reports. It is impossible for the engineer alone to obtain relief from the situation and he must present this matter to the taxpayer and officials of drainage projects so that they may join in the effort.

WATER WORKS MAINTENANCE AND OPERATION

Watering and Un-Watering an Industrial Plant and Its Relation to the Public Water Supply

By Wm. F. Wilcox, Superintendent Central Water Works, Tennessee Coal, Iron and Railroad Co., Ensley, Ala.

The only point on which there is a fundamental difference between an industrial and a public water supply is the question of political expediency, from which the industrial operations are happily free.

Magnitude of the Problem

As large industrial plants spread their various operations, the question of watering the manufacturing and un-watering the mining operations becomes a problem involving the expenditure of millions of dollars and much care and thought. It may be surprising to many to know that there are few cities, and practically no towns, that could handle the water supply of a reasonably large industrial operation. The requirements of industrial water plants, the oftentimes unusual conditions, and the character of many of the problems, varying in capacity, pressure and volume, make each installation a separate study. The designing engineer is called upon to consider the wide needs lying between the supply for a small town of, say, one hundred inhabitants, to the equivalent of a city of half a million population.

Diverse Nature of the Problem

We have the question of wells for some supplies; for others the use of water from streams, rivers and lakes, with the conditions varying from that of a town or city in comparatively flat territory to those of a town or city in mountainous country. Sometimes the question of drainage may be paramount in a mining operation, and sometimes the requirement of a manufacturing plant, with its large volume, and if circumstances favor a low head the conditions may approach those of a mechanically operated drainage system. In other manufacturing plants the problem may assume the general character of a large city pumping against a reasonably high head. It may, therefore, be seen that the industrial water supply problem is very varied and may be compared to the conditions which will be met by a consulting engineer whose services are rendered to a large and widely distributed clientele.

Six Grand Divisions of Industrial Water Supply

An industrial supply may, for convenience, be classified under six general heads:

(1) An abundance of pure, wholesome water for drinking and bathing purposes. (2) An adequate and satisfactory boiler water supply. (3) A constant and ample supply for condensing and cooling purposes. (4) The un-watering of mining operations and the disposal of the output. (5) Pumping, treatment and disposal of plant wastes. (6) Water under heavy pressure for hydraulic operations.

The first classification is naturally paramount, and in this day of liberal management on the part of large corporations it is given the closest scrutiny. With the present high development of the science of water treatment, this question may usually be solved even more readily than the third classification. But the first and second classifications are intimately related, assuming that an industrial operation has an ample supply of water; this supply must be further capable of yielding water under the first and second classifications, or sufficiently near some source which can be drawn upon for water meeting these requirements.

The several classifications will now be considered in more or less detail and under their proper headings, with a view to understanding more thoroughly what may be called the six grand divisions of industrial water supply.

Water for Drinking and Bathing Purposes

Considering the operation as a whole, we may assume that we are called upon to supply water to from 20 to 30 sub-departments of the operation, varying in their requirements from those of a village of 500 people to a small city of 25,000.

The health, happiness and general welfare of the employes of a modern plant are of prime importance. The best possible sanitary conditions, coupled with proper provision for the

housing of the employes, is one of the largest assets which a corporation may hope to have. Therefore, where local conditions do not meet these requirements, they must be maintained by the corporation. To this end many corporations have been compelled to expend large sums of money in the establishment of the most modern type of village and town, with adequate and proper water supply.

When these conditions are recognized and met it results in a healthy, happy and loyal set of operatives and a prosperous industrial organization. After providing a proper water supply, intelligent and careful scrutiny must be made of the water, and examinations, both sanitary and bacteriological, must be constantly made, and every effort put forth to insure an ample, pure and wholesome water supply for drinking and bathing purposes. And it must be impressed that drinking and bathing are the two essentials of what may be termed the domestic water supply department of an industrial organization.

Oftentimes the local public water supply is capable and willing and does meet the requirements of the several operations. In some other instances it may be desirable for the industrial operation to provide its own domestic water supply. Whatever may be the conclusion as to the source of this water supply, it must be remembered that every day the health departments of the corporations are constantly in touch with and carefully watching to see that this water is of the highest standard.

In mining towns, and sometimes in industrial plants, the water supply may be operated under the same general conditions as those governing the water supply of a village or town, and sometimes of a small city. If this should be the case, of course we would meet the identical problems as if called upon to design a water supply for a similarly sized community.

Keeping before us the prime essentials of a water supply, its purity, abundance and suitable volume and pressure for domestic and fire-fighting purposes, in some instances we must go further and provide for the softening or treatment of the water, should the best available source not meet the highest requirements of the present-day sanitary engineer.

Boiler Water Supply

The boiler water supply may vary in the many operations from a few thousand gallons per day, which may be taken from the domestic supply, to possibly 1,000,000 or 5,000,000 gals. per day, which may be required for the boilers of a reasonably large industrial plant.

In the smaller operations the boiler water supply may be dismissed as an instance. In the larger operations, after the boiler plants have begun to assume the output of 1,000 or even 50,000 horse-power hours, the boiler water becomes quite a question. We must consider the quality of the supply and its cost of delivery in more detail than we would for a smaller plant. The quality is the most important factor, for the boiler plant is necessarily the heart of any steam-operated industrial organization. It is not unusual to find filtration and softening plants handling 4,000,000 to 5,000,000 gals. of water per day, it having been found more desirable to filter and soften water, where desirable or necessary, rather than attempt treatment by boiler compounds, this being true especially of the larger plants.

It has often been found desirable to use water which has previously done work in cooling and heating, as many advantages may be obtained thereby. In this way we not only receive the benefit of the reclamation of the otherwise wasted heat units, but also materially reduce the cost of boiler repairs. In the larger industrial plants the boiler water supply, through this cycle of usage, may more than pay for the cost of its improvement, and usually does, when we consider the efficiency of the boiler plant, saving of time required for repairs, economy of operation and increased plant rating.

The water from mining operations sometimes carries in suspension free acid; the plants being small, if there is no available waste heat, these plants usually draw their water from the domestic supply as the most desirable and economical source.

Water for Condensing and Cooling Purposes

This is necessarily the largest operation of an industrial water supply, and causes the expenditure of more money per annum than the other five of the main subdivisions combined, and also yields the largest profit. It would be difficult efficiently to conduct any large industrial operation with steam power without a constant and ample supply of cooling and condensing water. It is more than probable that such a supply of water, even when compared with a reasonable and necessary amount, would make the difference between a successful and profitable enterprise and an unsuccessful one.

It therefore may be readily seen that such an important item as this supply becomes in the present modern industrial plant, when one considers its effect upon mechanical efficiency, a prominent question in determining the location of this class of enterprise. Some of the larger plants of this country have found it necessary to move from the ore and coal fields to the water supply. Some plants have unusually favorable conditions, both as to accessibility of their raw material and the availability of a suitable water source. In other localities the plants have been able to solve their condensing water supply difficulties by the installation of cooling towers and spray ponds or the construction of expensive reservoirs and impounding systems, and are now in successful operation. In plants of the character of blast furnaces, it is found that approximately 10,000 gals. of "make-up" water must be supplied for each ton of production, and to this amount may be added from once to twice as much rehandled water. Water is now rehandled through this class of plants for several reasons, and it is dependent, first, upon the temperature of the water, and second, upon the character of the operation, with its more or less elaborate and efficient systems of cooling and condensing. It is desirable, where possible, to use the fresh "make-up" water through the condensing apparata of such units as blowing engines and electrical generators, as the cooler water produces a more satisfactory and higher vacuum, and improves the cycle of efficiency.

After the water has passed the condensers it is generally rehandled with low-head pumps, sometimes with and sometimes without the addition of cooler water, directly to the cooling equipment of the blast furnaces proper. From quite a number of these uses sufficient water of proper quality may be reclaimed at a temperature of approximately 120 deg. Fahr., and from there carried to the water-softening plants for boiler purposes. In some plants the water may be further used for such valuable purposes as the granulation of slag; this is becoming quite a saving since cement plants have begun to utilize this previous source of waste, and in cases where the slag has not been a waste this utilization may increase what may have been only a nominal profit into a satisfactory one.

If the industrial plant shall be of the character of a steel plant, manufacturing finished products, the ultimate consumption of water may reach 20,000 to 25,000 gals. per ton of finished product, and even in these further operations it is necessary to rehandle from an equal to a double amount of water before it is finally turned away. Properly constructed and operated modern plants, which take their water to the best advantage, have been able to reduce materially their cost of operation by the reduction of the amount of steam used and the increase in the length of life of those parts of the operation which are usually subjected to a very high heat.

With the realization of the advantage of ample supplies of cooling and condensing water, it is now becoming a rarity to see large non-condensing engines. Even in that class of operations which require the use of non-condensing engines we are able to take this exhaust steam into a receiver and thence

to low or mixed-pressure turbines, which are today in many plants generating thousands of kilowatts of electricity from what was previously waste heat and energy.

The installations for plants handling the primary water supply are necessarily varied. In the larger plants it is not unusual to find three classes of engines, with individual units capable of handling 30,000,000 gals. per day each, and boiler plants, stoker-fired, and equipped with superheaters and all of the latest heat-saving devices.

The larger units in the primary plants are, first, the reciprocating engines, either triple-expansion or cross-compound, condensing engines, varying from 125,000,000 ft.-lbs. duty for units of the 5,000,000-gal. capacity to 200,000,000 ft.-lbs. for 30,000,000-gal. triple-expansion. Some of the most interesting units are the cross-compound condensing engines of 12,000,000 to 15,000,000-gal. capacity, which have developed as high as 165,000,000 ft.-lbs. duty when operating with 150 lbs. steam and 50 degrees superheat.

A second class is the centrifugal pump in the later and larger sizes, driven by steam turbines, with as many as 14 stages, and which, running under 28 ins. of vacuum, give as high as 135,000,000 ft.-lbs. duty.

The electrically-driven, centrifugal unit is a very useful one, and the selection of the motor depends upon the characteristics of the load of the industrial operation, as to whether or not the motor shall be synchronous or of the induction type.

It is desirable, in a plant putting out from 40,000,000 to 50,000,000 gals. per day, to have two 30,000,000-gal. units and two 15,000,000-gal. units. This gives a very flexible and dependable installation, and allows the operation of the units up to their best capacity and economy.

In some localities most of the plants have demanded installation of additional supplies. Under these conditions it is not unusual to find that the new station is of the highest type of engine and boiler equipment and operates under practically 100 per cent. load, the older station being held as a reserve. One particular instance is in mind where for five years the new station operated under a load of 100 per cent. average, by Venturi meter, and the older or abandoned station was held as a reserve. When this class of installation is encountered, marked difference is shown between the well-designed, etficiently operated station, with a high-load factor, and the old station, which is generally apt to be a succession of additions, and to contain machines which are inefficient from a present-day standpoint, but reliable and valuable when held as reserves.

In the rehandling water problem it has been found that the head is largely the controlling factor of the unit capacity for such uses as condenser circulation and mechanical cooling. This class of machinery is more or less varied in use and condition, and the principal choices on sizes of 5,000,000 gals. per day are the crank and flywheel reciprocating and the centrifugal pump, either electrically or steam-driven, the final selection being largely governed by the permanence of the operation, available space and proper operating head.

It is impossible to lay down any general rule of selection. The installation must necessarily be governed by the solution of the particular problem in hand.

After an examination of the above general outline it may readily be seen that where these many uses are carefully considered and worked out so as to balance properly, the large industrial plants are wise in the expenditure of large sums of money to provide the necessary water for this class of uses.

In laying out a system having in mind these particular uses, one would be largely governed by the same reasons that would apply in designing a fire protection for a large city. The volume of water to be provided for must be carefully worked out and careful consideration given to the factor of safety, and considerable thought should be given to the question of future demand. For as the improved equipment shall be discovered or produced, the use of water will be increased whenever the economy of any operation may be materially improved.

The pressures for each requirement of the several operations must be thoughtfully considered, for each operation must have that pressure which will give the most desired efficiency in daily operation. The reliability of the supply is possibly the greatest single point on which the operating management judges the efficiency of the water supply division.

Unwatering Mining Operations

In mining operations provision must be made for taking care of the infiltration of water through the seams, fissures and faults. Some of the mining operations are very deep, being as much as 5,000 ft. below the surface of the ground. Some of them, although extending 3 or 4 miles back under the ground, are comparatively shallow and may be easily unwatered through bore-holes. As a general rule, the amount of water to be contended with is largely controlled by surface conditions, which are, of course, dependent upon the season of the year and the rainfall.

In some instances mining operations are in broken or faulty ground, and provision must be made for heavy inflows of water during flood periods. The types of pumps which are most generally in use now are electrically driven and may be of the triplex-geared displacement design or else of the centrifugal type. These two types have each their particular advantages and are used at the option and judgment of the engineer.

Nearly always the cost of unwatering a mine is an expense chargeable against the operating or mining costs. Wherever it is possible, the water from the mines is utilized largely, for two purposes: where free of contamination, the water is desirable for the drinking supply. The most general use, however, is for cooling purposes on such operations as require very low temperatures, it having been found that on operations similar to the by-products distillation plants, the cost of unwatering a group of near-by mines may be absorbed by utilizing this water in increasing the products of distillation. For as a general rule the mine waters run about 18 deg. C. as against 28 deg. to 30 deg. for surface water during the summer months.

Disposal of Plant Wastes

The problem of the disposal of plant wastes is looming up larger and larger every year. The increasing number of industrial plants and the widely varying and ever-increasing character of the run-off from these plants are now the subject of much thought.

It is very noticeable around Pittsburgh that surface waters are heavily charged, and the analyses of the water at McKeesport, as shown in the water plant of that city, indicate to one interested a large and varying quantity, as well as changing substances, of the chemicals carried in solution.

Many of these plant wastes are capable of dilution, so that they become harmless. Sometimes it is possible to neutralize alkaline water by combining it with some other waste which is acid, and vice versa. For one of these latter purposes pipe lines have been laid from eight to ten miles, in order to neutralize the wastes and protect adjacent property.

The policy of "live and let live" among the manufacturers and the laws governing the riparian rights make it very desirable that the plant wastes be carefully watched. Where two or more plants are located upon the same stream, the water may be used several times before passing the plant farthest down stream. It is, therefore, not unusual to note that many devices are being installed to cool, treat and clarify the wastes from each plant, so that the rights of each and every one may be protected, and the individual efficiencies held at the highest point.

In addition to this, nearly all wastes are valuable, if of sufficient quantity, and therefore the cycle of efficiency ever tends

to reduce the careless distribution of deleterious substances which have heretofore been thrown into the streams.

Heavy Pressure for Hydraulic Operations

The amount of water used for these purposes is not very large, but as a rule the machinery is very heavy and the cost of installation very large. For the present, direct-acting pumps are largely used, but a few of the newer installations have centrifugal pumps. The pressures range from 550 to 800 lbs.

The principal uses for this class of water are the operating of tilting furnaces carrying as much as 100 tons of molten metal; manipulators for handling and turning ingots, opening and closing large gas valves; the operation of elevators carrying hot metal or explosives, and which demand steady, safe operation; the operation of heavy shears and punches, wheel presses, testing machinery and other similar apparata which require heavy power and slow operation.

In the operation of this class of machinery it is necessary to see that the water is filtered and of good quality, so as to keep down repairs due to erosion and corrosion.

General Summary

As usually outlined, the general scope of industrial water supply may be divided into few heads. These major divisions of operation are each many times subdivided. The investments for the several operations vary from a few hundreds of dollars to hundreds of thousands of dollars.

An engineer would at times be impressed by the high class of the installation, with its complete, labor-saving devices, with their attendant economies. On the other hand, one would feel inclined to wonder at some very inefficient operation, did he not know that the operation was temporary, or perhaps a break-down emergency. The general scope of the work and the multitudinous difficulties and differences make a very interesting and instructive study. In no class of practice would one be more impressed with the opportunity and value of the water works engineer. In this field the engineer has possibly the largest opportunity for intelligent design and selection, and the experience and ability of the engineer and his value to the organization may be easily determined by a careful study of the various operations designed and installed.

The problems coming under the head of industrial water supply are many, but they are being very carefully worked out, and the industrial plants are doing their part to protect all interested parties.

FROM WORKERS IN FIELD AND OFFICE

Attack on Chicago Creosote Oil Specification Fails

Editor of MUNICIPAL ENGINEERING:

Sir—Prior to 1912 the city of Chicago suffered from the same type of unfortunate experience as many other cities in connection with creosoted wood block pavements.

The use in wood paving blocks of creosote oils, which were adulterated with coal tar and water-gas tar, or which had been stripped of certain valuable elements, resulted in the expansion and bulging of blocks, the distortion of curb line, sticky, tar-covered streets in summer and slippery pavements in winter.

The trouble was so general and so serious that the city officials were constantly flooded with complaints from property owners and civic bodies. It soon became a question of either securing a cresote oil that would overcome these troubles or of abandoning the use of wood block pavement.

In 1912 the city discovered that a creosote oil of certain properties would give satisfactory results and the present Chicago Specifications—known the country over—were adopted. Since the adoption of these specifications, the city has had good service from its wood block pavements.

The Chicago Specifications

In brief, the Chicago Specifications provide that creosote oil to be acceptable for treating wood paving blocks must be of certain definite quality and must meet certain tests, of which the following are the more important:

A—When distilled, not more than 22% of the oil shall distill below 235 degrees C. and not more than 40% shall distill below 315 degrees C.—thus preventing the use of an oil containing volatile elements which soon leave the wood.

B—When distilled under certain specified condition, that part of the oil which distills between 250 degrees C. and 315 degrees C. must contain not less than 5% of tar acids—thus protecting the city against the use of creosote oil which has been stripped of its valuable acids or which has been adulterated with petroleum products.

C—The amount of unsaponifiable oil in the distillate coming over between 250 and 315 degrees C. must not exceed 1½% of this distillate—a further means of preventing adulteration with water-gas or petroleum products.

D—When distilled up to 355 degrees C. the residue must be waxy instead of brittle, and, when placed on white filter paper and warmed, the resulting oil spot must show a clear amber color. If this spot appears dark or black it shows adulteration with coal tar.

So successful have these specifications been in shutting out the use of adulterated or stripped oils that recently certain parties brought suit to enjoin the city of Chicago from enforcing its specifications.

These parties alleged that the specifications were both unfair and unnecessary; that it was impossible to produce a pure creosote oil of the above specifications, which would contain a minimum of 5% tar acids in the fraction stated, without infringing a patent owned by P. C. Reilly.

The decision of the court is of great importance to the creosoted wood paving block industry and to all city officials and engineers interested in this subject.

After a trial extending over nearly six days, the court decided that the specifications were just and fair; that the city was entirely within its rights in using specifications that would insure a pure cresote oil of the desired quality, and that there was not only an ample supply of tar from which such oil could be distilled, but, further, that any creosote oil manufacturer should be able to manufacture such an oil if willing to do so, as it in no way conflicted with the aforesaid Reilly patent.

It has proven that the Chicago oil could be produced at a temperature below 700 degrees F., while the Reilly patent covers products that are produced above that temperature only.

The Chicago Specifications have given Chicago perfect protection against bulging, bleeding and breaking down of creosoted wood block pavements. This so-called Chicago oil represents the minimum of quality that will insure perfect results in wood blocks. Very truly yours,

Chicago, Ill. J. A. MEYER.

American Built Military Roads in France Will Endure

Editor Municipal Engineering:

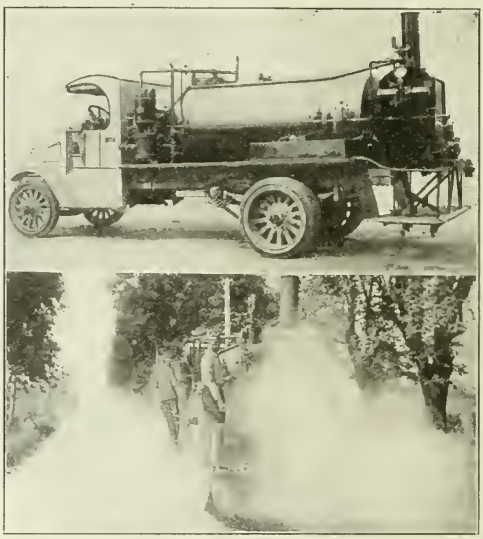
Sir—When the history of this war has been written the vital part good roads have played in the great struggle will be more fully realized than at present. At the start motor trucks leaped to the front as the modern pacemaker of flexible transportation, and ever-increasing war needs have demanded new roads and better roads as most necessary for the proper backing up of fighting forces.

Motor trucks by the thousands will contribute an enormous advantage to U. S. road engineers engaged in new construction back of our lines. It is estimated that 1,200 miles of highways will be built in 1918 by American road engineers in the rear of the firing line in France. To the special road building battalions is delegated the important task of keeping lines of communication constantly open, and Mack trucks working in conjunction with modern American road machinery will help to build new strategic lines and keep communicating roads in constant repair. The Mack fleet will be composed of several thousand dump trucks, hot road oilers, pressure sprinklers for making water-bound macadam, gasoline tank trucks, printing press trucks for printing blue prints, instructions, plans, reports, etc., machine shop trucks, blacksmith and tool repairing trucks.

Although France is particularly well endowed with good roads, it is often necessary for military reasons to construct many new lines. An estimate places the present mileage of French roads at 1 mile of road for each 1½ square miles of ground surface. The tremendous task of keeping these roads in perfect condition and building new ones at the same time can well be imagined when it is realized that so far as wear and tear are concerned war traffic is ten times as great as that on Fifth avenue, New York.

Most of the roads of France are built of water-bound macadam. The peculiar nature of the French soil, which is of limestone formation, lends itself readily to compaction under the road roller and makes a very good road building material, although it requires constant maintenance. The British, however, introduced the tarred surface road, and an increasing mileage of that type is found back of the British lines. One of the principal objections to the water-bound macadam road near the front is the dust which rises from it in dry weather under heavy war traffic. Clouds of dust draw artillery fire from the enemy, and for this reason U. S. engineers, in planning road construction and maintenance near the American front, will probably utilize large quantities of tar coating which is freely obtainable in France.

Of course the pressing object of American road construction is to provide for the immediate needs of our forces, but the work carries with it both utilitarian and historic value.



TYPE OF MACK MOTOR TRUCK USED BY U. S. ROAD BUILDING BATTALIONS IN FRANCE.

American system and modern methods promise to contribute many enduring benefits to France. Our road building battalions are going about their work scientifically. All is not destruction that comes out of war, and many American-built highways will remain to become of immeasurable value to France in conducting her commercial and social intercourse.

Very truly yours,

D. O. Skinner.

New York City. International Motor Co.

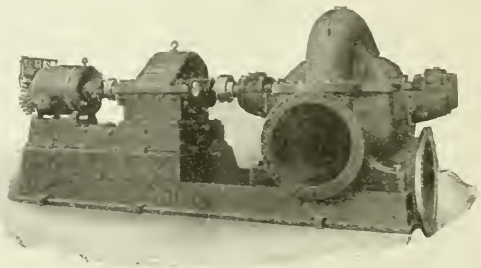
Plant Units and Lay Outs

New Feature in Centrifugal Pump Design

Illustrated herewith is a new design of pump manufactured by the Wheeler Condenser and Engineering Company, that is of special interest because of the unusual position of the suction opening. This opening, it will be noted, is directly beneath and parallel to the end bearing. In this position it is out of the way, yet it is in a convenient place for the erection men, for inspection, for upkeep, etc.

This arrangement makes it possible to place a pumping unit in a room of small ground area—considerably smaller than where the suction end is opposite the outlet end, as is the most common practice. In many cases this also facilitates the making of pipe connections, sometimes saving elbows and reducing the length of piping more or less.

The capacity of the particular pump shown is 45,000 gals.

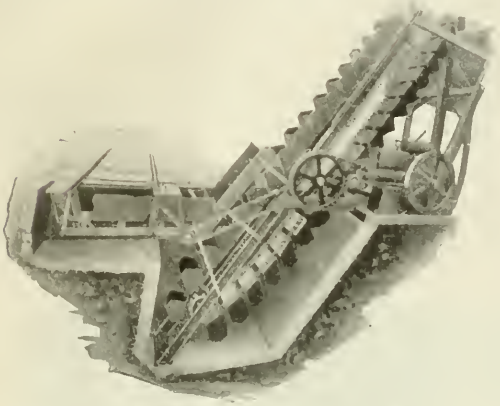


CENTRIFUGAL PUMP WITH SUCTION OPENING BENEATH AND PARALLEL TO END BEARING.

per minute against a head of 20 ft. The diameter of the outlet pipe is 36 ins. The speed of the pump is 240 r.p.m. and is coupled by a 10-to-1 reduction gear to a steam turbine whose speed is 2,400 r.p.m.

Automatic Car Loader and Unloader

The "Columbus" automatic car unloader consists of an all-steel reciprocating feeder placed between the ties and parallel with them, and a steel bucket elevator attached. For power, gas, oil, steam or electric current may be employed. The ma-



AN AUTOMATIC CAR UNLOADER DRIVEN BY A 7½-H. P. OIL ENGINE.

terial elevated can be discharged into a bin, a conveyor, or disposed of otherwise as desired.

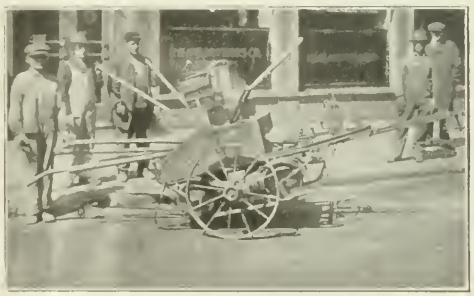
By reversing the position of the feeder and elevator, cars can be loaded quickly with this device. The loader and unloader are made to suit the size of the material to be handled, in the capacity desired.

The feeder consists of a rectangular box, with steel sides and bottom, carried back and forth on flange roller bearings running on a steel under-frame. A crankshaft joined to the feeder by a connecting rod drives it back and forth. The forward movement of the feeder carries the load to the elevator, delivering part of it into the bucket on the return stroke, while the load in it is prevented from returning by a stationary back plate located inside and at the rear end. The elevator is of the continuous bucket type, provided with a take-up for the adjustment of bucket chains. A typical "Columbus" automatic car loader, driven by a 7½-h.p. oil engine is here illustrated. It is claimed this equipment will handle from six to eight cars of coal per day with but a single operator.

New Machine Successfully Employed in Repairing Asphalt Streets

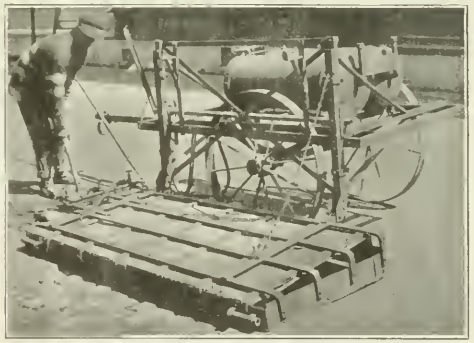
In heating the tools used in making repairs to asphalt street pavements, heaters of the old type often made so much smoke that they were considered a public nuisance. Complaints on this score have been common in both residential and business districts, in the former from housekeepers and in the latter from business men. This cause has operated to reduce somewhat the popularity of asphalt streets, which are easy to repair and which should be repaired quickly without nuisance or inconvenience to owners of property abutting on the street. The tool heater of the old type not only emitted dense clouds of black smoke, comparable to a "smoky factory chimney," in the words of an experienced asphalt foreman employed by a big city, but its bulk obstructed the street and its inefficiency kept it standing long in the same place.

One of the pictures shown herewith illustrates a new type of asphalt tool heater that not only heats tools quickly and keeps them hot, but eliminates entirely the smoke and fumes



VIEW OF "PHISTO" KEROSENE ASPHALT TOOL IN OPERATION.

produced by the older types of tool heaters. This new heater also eliminates the carting of wood, coal and coke for fuel purposes and no ashes are produced. This machine operates on kerosene fuel. The view shows the machine in successful operation on the principal boulevard of one of the largest cities in the country. The small amount of space occupied by the heater, adjacent to the curb, will be noted. Although operating in full blast it will be seen from the picture that the machine was not giving off any smoke and it did not emit fumes.



VIEW OF "PLUTO" ASPHALT SURFACE HEATER IN HEATER IN OPERATION.

In operation this kerosene tool heater requires but little attention from one man. While the tools are kept hot they are not burned. The work of street repair is speeded up because the men have hot tools all the time. The available truck and team capacity is used entirely for transporting the materials used in making repairs and not at all for hauling wood and coal to the heater and ashes away from it. Experience indicates that 25 gals. of kerosene will run this heater at full capacity for 10 hours continuous operation. These Phisto Kerosene Tool Heaters, distributed by the Alger Supply Co. of Chicago, are proving successful wherever used. They are in service in a number of the larger cities. On a consumption of 3 gals. of kerosene per hour the furnace will keep constantly hot 14 tools, 3 pails of binder and 3 scoop shovels.

The other illustration shows the Pluto Asphalt Surface Heater, distributed by the same company. It will heat 36 sq. ft. of sheet asphalt surface to a proper consistency for handling in from 5 to 7 minutes. It saves both teaming and materials.

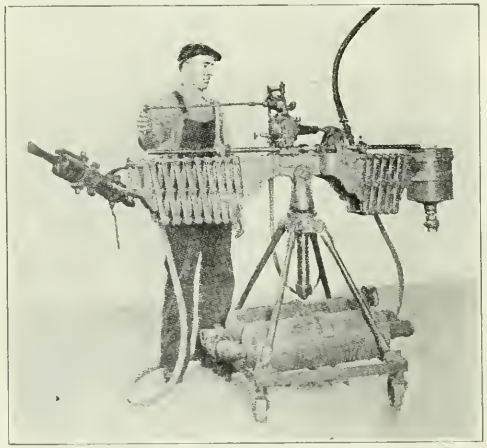
It can be operated by one man and the fuel required is 6 gals. of kerosene per hour.

In the illustration the surface heater is shown driving the moisture off the old granite block underlying the sheet asphalt surfacing so that the paint coat which binds the wearing surface to the foundation will adhere.

A Mining and Tunneling Machine

The Jackson mining and tunneling machine, illustrated herewith, is for excavating in rock; it is claimed the machine will reduce the cost of rock excavation in tunnels and mining properties by as much as 70 per cent. It is claimed that the device will eliminate the use of explosives.

This machine is designed to carry in suspension all portable tools, thus increasing their utility and range of operation.



A NEW MINING AND TUNNELING MACHINE.

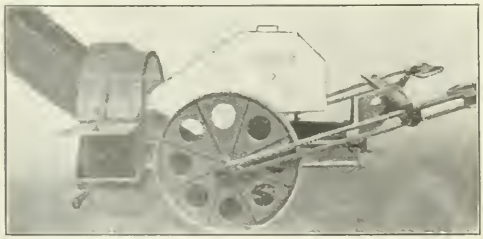
The tool holder has proved a necessity in facilitating the use of pneumatic riveters, chippers, busters, blacksmithing tools, jackhamers, tamping tools, electric grinders, drills, coal cutters, etc.

This machine is recommended for use in excavations in rock, hardpan and clay tunnels, for cutting asphalt and pavements of all kinds, breaking concrete and frozen ground, and for driving sheeting and tamping earth during backfilling operations.

It is caimed that the tool holder will reduce the cost of operating portable tools by from 25 to 50 per cent.

A Rotary Paddle Wheel Box Car Loader

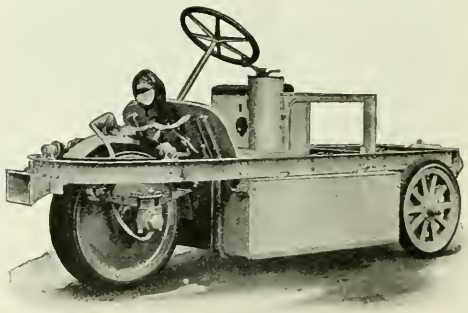
The Ottumwa portable, rotary, paddle wheel box car loader is for loading sand, gravel, crushed stone and other small bulk materials. It is claimed that one man with this loader will do the work of from four to ten laborers. The loader has few working parts. It is of rigid and strong construction. The material to be loaded is received in a circular receiving chamber through a gravity chute and is discharged to either end or the car by means of a four-blade paddle wheel revolving in this chamber. The distance and height to which this material is discharged is regulated by a hinged plate over either opening. An electric motor of 8 to 10-h.p. furnishes power. It is mounted on a portable truck and can be wheeled by man power from one point to another.



VIEW OF PORTABLE, PADDLE WHEEL BOX CAR LOADER.

An Efficient 3-Wheel Tractor

The Couple-Gear 3-wheel tractor, with one pulling wheel forward, is adaptable to the handling of wagons loaded with commercial freight over ordinary city streets. In using this tractor no change is made in the wagon, or the method of handling the wagon, with the exception that the wagon pole tongue is removed and a short bale tongue is substituted.



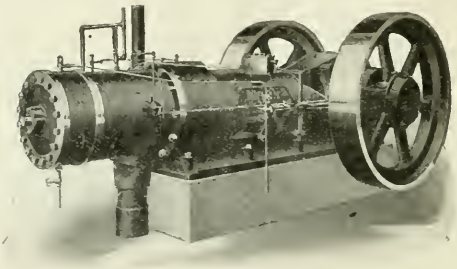
COUPLE-GEAR 3-WHEEL TRACTOR.

This machine is offered in the one-wheel drive only, for use over city streets or tramways. It is also built with all three wheels as drivers, for use under more difficult conditions.

It is claimed that one man with the tractor, used in conjunction with two wagons, one wagon being loaded while the other is being delivered, can handle more than two men with teams.

An Improved Oil Engine

The Primm oil engine is built to deliver cheap and safe power. It is a heavy-duty engine, operating on fuel oil, crude oil, kerosene or distillate. It is not a gasoline engine with an oil attachment. The development of this engine has been under way since 1902. It is a semi-Deisel engine, that is, the



VIEW OF PRIMM HEAVY-DUTY OIL OR DISTILLATE ENGINE.

pressure employed in the cylinder is between the high-compression Delsel type and the ordinary low-compression engine.

The horizontal, single-cylinder, two-cycle, crosshead construction is used in preference to any other type to get away from three faults of the vertical type, namely, inaccessibility of bearings, difficulty in removal of crank shaft and piston and difficulty of proper lubrication of the cylinder. The single cylinder was adopted to eliminate working parts. The line comprises engines from 15 to 150 h.p., all of the single-cylinder, two-cycle type. These engines are adaptable to any kind of work. They are made by the Power Manufacturing Co., Marion, O.

A Popular Line of Sanitary Carts and Wagons

When several of the suburbs, within a radius of 5 or 6 miles of Wheeling, W. Va., desired to make arrangements with the city to burn their garbage in the Wheeling crematory, the city officials insisted that the garbage be delivered to the crematory in sanitary wagons to prevent nuisance on the streets. As the Holzbog wagons owned by Wheeling were satisfactory to the officials of the suburbs, wagons of this type were purchased with the approval of the health department.

Prior to using Holzbog sanitary carts for garbage, night soil, etc., the city of Elkins, W. Va., hauled its garbage in open

VIEW OF HOLZBOG SANITARY WAGON, USED FOR HAULING WET GARBAGE, ETC. CIRCULAR TYPE OF BOTTOM FACILITATES CLEANING.

wagons, which were a menace to the public health as well as a nuisance. The carts were found, after due trial, to be sanitary in all respects as well as convenient.

J. A. Magruder, City Engineer, Danville, Va., reports three 4-wheeled Holzbog dump carts in the service of his city. They are used for night soil, wet garbage, etc. He finds that the circular bottom of these cart beds, reducing corners and angles to a minimum, makes them very easy to clean, and with the close-fitting cover they are as near odorless as a cart used for these purposes can well be.

The village of Hibbing, Minn., has 4 steel garbage wagons of Holzbog manufacture. They are of 65 cu. ft. capacity. They have been used for 2 years in hauling to dumping grounds 3 miles from town without complaint of odors from the wagons.

Gravity Brick Conveyors Save Time and Money for Contractors

Brick paving contractors find that a big saving in time and money is effected in the use of gravity brick conveyors. Thus C. W. Hughes of Malta, O., who has a 16-ft. carrier section in service, reports the placing of 32,000 paving brick in a day when using a conveyor with 8 men, and only 18,000 brick by the wheelbarrow method with 10 men. On this job, in Guernsey County, the street width was 30 ft. Two men placed brick on the carrier, six men stacked for setters and there was one setter and one helper.

Springer & Rogers of New Philadelphia, O., have two 16-ft. and one 8-ft. section, with which they lay an average of 28,000 brick per day. Their biggest day was 36,000 brick, using 14 men on brick and 6 men on the cushion. The street width was 46½ ft. Four men placed brick on carrier, 8 men stacked for setters and 2 men set brick.

H. K. McCollum of Fort Worth, Texas, has two 16-ft. carrier sections. He places from 30,000 to 50,000 brick per day. Using the carrier and 10 men he placed 52,000 brick in one day. On this job the street width was 46 ft. Two men placed brick on the carrier, 5 stacked and 1 man set brick.

The Adams Bros. Contracting Co., of Zanesville, O., have 2 16-ft. carrier sections. They lay 25,000 brick per day on the average. Their best day with the wheelbarrow system and 12 men was 30,000 brick, and with the conveyor system and 9 men, 32,000 brick. This was on a 16-ft. width of street with 4 men putting brick on the conveyor, 4 men stacking and 1 setting brick.

The Smith Engineering and Construction Co. of Warren, O., have had two 16-ft. carrier sections for several years. They lay between 20,000 to 30,000 brick per day on the average; 30,000 was their best day, with 10 to 11 men. This was on a 30-ft. street, where 4 men placed brick on carriers, 1 to 6 men stacked and 1 man set brick. This company never used the wheelbarrow method. Before purchasing carriers they carried the brick by hand. They state that the conveyors enabled them to dispense with the services of 4 men.

The W. M. Brode Co. of Newcomerstown, O., have one 16-ft. carrier section in service. They lay, on the average, 25,000 brick a day. Their biggest day, with 10 men, was 30,000 brick. This was on a 16-ft. street with 6 men placing brick on carrier, 3 men stacking and 1 setting.

McAlonan Brothers of Akron, O., have two 14-ft. carrier sections. Their average is 21,000 brick laid per day. Their best day using the brick tong method and 22 men was 28,000. Their best day with the gravity brick conveyor and 14 men was 40,000 brick laid. This was on a 36-ft. street, where 4 men placed brick on the carrier, 8 men stacked and 2 men set brick. The conveyor system cut 8 men off the payroll on this job and more work was done than with the larger force.

The A. C. Loomis Co. of Mattoon, Ill., have two 16-ft. carrier sections and lay 28,000 brick per day on the average. Their best day was 30,000 brick laid, using 10 men: 4 placing brick on carrier, 4 stacking and 2 setting.

Henderson Brcs. of Coshocton, O., have two 14-ft. carrier sections. They lay 20,000 brick per day on the average. The largest number of brick they placed in one day, with 8 men, by the wheelbarrow method, was 30,000. The largest number placed in one day, with 8 men, by means of the conveyor system, was 40,000. This was a 30-ft. street job. Four men placed brick on the carriers, 2 men stacked and 2 men set

brick. Thus the output of the gang was increased 33% per day by the use of the conveyors.

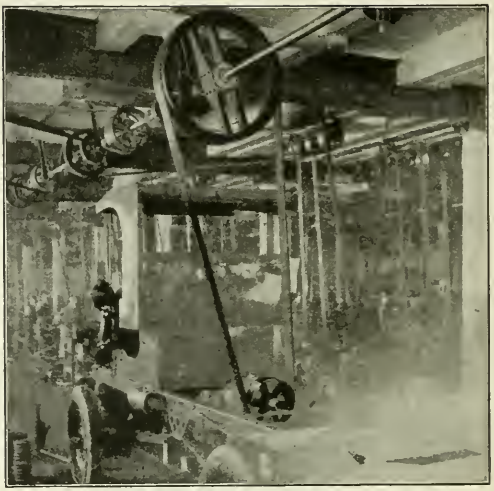
In all the foregoing cases the conveyors used were the Matthews gravity brick conveyors. The contractors found that these carriers saved rehandling the brick, insured having the right number of brick at hand and obviated chipping and breaking of brick. They report ease in adjusting the conveyor sections to fit various widths of streets. The carriers bring the brick to the setters clean and keep mud off the newly laid brick until after the joint filler has been poured.

Motor Truck Furnishes Power to Operate Tool Room of Factory

Recently a Duplex 4-wheel drive motor truck supplied power to operate a department of a factory which otherwise would have been forced to close.

When the flood waters of the Grand River at Lansing, Mich., made impossible the operation of the Michigan Power Company's plant among the scores of factories affected was that of the Duplex Truck Company.

However, it was not necessary to close the Duplex tool room because of a novel arrangement whereby power was furnished in this department by a Duplex truck. A pulley wheel was attached to the rear of the chain case shaft of the truck and a belt transmitted the power to the line shaft above. The Duplex supplied ample power to operate all the machinery in the tool room.



MOTOR TRUCK SUPPLYING POWER TO OPERATE PART OF FACTORY IN AN EMERGENCY.

Advance Information on Big Jobs

Further Information on Roads Reported to Washington by the States as Vitally Necessary

In the April issue of Municipal Engineering information was published on pages 163-167 covering the roads reported to the U. S. Office of Public Roads and Rural Engineering by several of the states as vitally necessary to the transportation system and as aids to increased agricultural production. The data given in that article covered the following states: Florida, Illinois, Indiana, Kansas, Maine, Michigan, Mississippi, Montana, Nebraska, New Hampshire, New Jersey, Rhode Island, Tennessee, Utah, Washington and Wisconsin.

The present article gives similar information covering the following additional states: Alabama, Colorado, Connecticut, Idaho, Maryland, Massachusetts, New York, North Dakota, Ohio, Oklahoma, South Carolina, Texas and Wyoming. In every case the information given is taken directly from letters to the editor by officials of the several state highway departments.

Alabama

W. S. Keller, Engineer, State Highway Department, Montgomery, writes:

"Prior to the passage of the Federal Aid Road Law, Alabama, by legislative enactment, had designated a system of state trunk roads, state aid being limited to this system, except where all trunk roads in a county were completed. The Secretary of Agriculture ruled that Federal aid, likewise, would be limited to this system. Twenty-six projects were submitted to and approved by the Secretary of Agriculture before the State Highway Department was requested to designate the relative essential military value of the roads to be constructed. All of these projects having been approved and nearly half actually under construction, consent was given for the construction of the entire number. One project located in a county where the trunk road system was already completed, and not having been approved, has been held up pending more definite information as to its military value. Construction work on twelve projects involving a total expenditure of $279,937.43 is now well advanced. The twenty-six projects approved carry a total estimate of $580,515.17, of which $283,051.85 will be paid by the government.

"We could not anticipate our work under the Federal allotment for the fiscal year 1919, as under our law the counties have to supply the greater portion of the state's fund and file request for Federal aid by April 8.

"A number of the projects are being held up on account of inability to secure railroad transportation.

"Eight state aid projects involving a total of $62,808.71 are under way and will be completed within six months.

"All of the work mentioned, both Federal and state, is confined to bad links in the state trunk road system. About 3,000 miles are comprised in this system, of which not more than 1,200 miles remain to be constructed."

Colorado

J. E. Maloney, Chief Engineer, State Highway Commission, Denver, writes:

"For 1918 the expenditures will be somewhat larger than for 1917, as most of the counties have levied slightly increased taxes for road and bridge purposes, but the amount of actual work performed will probably not be increased, as the increased wages and cost of materials will probably offset the increased amount available."

In 1917 the grand total of all funds expended by or under the supervision of the State Highway Department, exclusive of fiscal costs, amounted to $1,470,000. Of this amount $703,000 was from state funds and $767,000 from local funds.

Connecticut

Charles J. Bennett, State Highway Commissioner, Hartford, writes as follows concerning the participation of the state in the improvement of roads especially desired by the United States government to assist in the prosecution of the war:

"Late last year this department constructed a section of road between Groton Center and the submarine base, on the east side of the Thames River, at the request of the War Department. This improvement was approximately two miles in length.

"The state will very shortly start work on the improvement of the extension of this road from the submarine base north to the city line of Norwich, Conn. This also is an improvement desired by the State Council of Defense.

"With reference to your inquiry concerning the work that counties are to do, be advised that the counties in Connecticut have no jurisdiction whatever over road work, with the exception that in event a town neglects to repair a road (other than a state road) a petition may be brought to the county commissioners, and they can order a town to make proper repairs. In event the town does not carry out the instructions of the county commissioners the county may then repair the road and collect the cost from the town at fault.

"We quote from a letter written February 8, 1918, to the chairman of the executive committee of the American Association of State Highway Officials:

" 'The construction work to be undertaken is confined to the main roads, having in mind Director Page's statement regarding the advisability of constructing only such roads as serve through traffic.' "

Idaho

H. C. Allen, State Highway Engineer, Boise, writes:

"We contemplate the construction of a portion of the north and south highway between Grangeville and Whitebird, in Idaho County, a distance of 22 miles, at a total cost of $247,000. This road is the only possible route connecting north and south Idaho and will help to open up large cattle and farming country and gives easy access to forest areas adjacent thereto. This is known as project No. 6 and is first in importance.

"Also a portion of the Sawtooth Park highway in Lemhi County, between Salmon City and the Pahsimoroi River, a distance of 38 miles, at a total estimated cost of $300,000. This road will serve a large fertile farming section and will be the only road between the Pahsimoroi River valley and the railroad terminus of Salmon. This is a part of the trunk road through central Idaho to Montana. This road is known as project No. 5 and is sixth in importance.

"Also three sections of the Lost River highway in Custer County, between Mackay and Challis. We are desirous of constructing about 39½ miles of this road. The total distance between Mackay, railroad terminus, and Challis is 57 miles. The first stretch, between Mackay and Dickey, a distance of 18 miles, is estimated to cost $77,500; the next stretch, between Dickey and Challis, a distance of 20 miles, at a cost of $70,200, and the third stretch, a distance of 1½ miles, between Dickey and Challis, at a cost of $7,300. The total on the three projects being $155,000. These are known as projects Nos. 2, 3 and 4 and are third, fourth and fifth in importance, respectively.

"This road is a link in the only road between Mackay, railroad terminus, and Challis, also to large mining district along the upper Salmon River. All minerals from this mining section are now freighted to Mackay as well as the stock and farm produce from Challis and vicinity. This road is a link in the road between Mackay, Challis, Salmon and other points beyond.

"We are desirous of constructing these roads this year and are submitting all the data and project statements on same to the District Engineer, U. S. Office of Public Roads.

"In addition to the above we expect to construct about twelve miles of the North Pacific highway in Kootenai in connection with Section 8, Forest Service, of the Federal Road Aid act. This stretch of road will cost about $150,000."

Maryland

H. G. Shirley, Chief Enginer, State Roads Commission, Baltimore, writes:

"I have been unable to advise you before this what work the State Roads Commission contemplated doing during the coming two years as the Legislature was in session and we did not know how much money would be available. However, the Legislature adjourned yesterday, April 2, and I am glad to say they appropriated us something like $8,000,000 for the next two years for construction and maintenance. The commission will get together some time in the near future and lay out a plan for the expenditure of this money."

Massachusetts

A. W. Dean, Chief Engineer, Massachusetts Highway Commission, Boston, writes:

"The roads sent on the schedule with estimated costs and with descriptions showing their importance were forwarded to the U. S. Office of Public Roads and Rural Engineering early in March and are as follows:

"In town of Hanover, Plymouth County, between town of Norwell and town of Kinston (Boston to Plymouth). Estimated cost, $39,000. This is a missing link on the main inside and shortest line between Boston and Plymouth. It intercepts important cross roads to Brockton, Rockland and many towns. It is all through a farming district supplying milk, produce, etc., to the industrial centers.

"In Malden, Melrose, Saugus, counties of Middlesex and Essex, being road from Boston to Newburyport. Estimated cost, $28,200. This is on the main inside line from Boston to Newburyport and so on to all points in New Hampshire and Maine. The shortest route as well—connects Boston and the metropolitan district with farming communities, Essex County, etc. Essex County farm products, 1910 census, $2,796,000 a year.

"In Danvers, county of Essex, being road from Salem to Lawrence. Estimated cost, $31,000. Main line between Lawrence, Haverhill and Salem. Road built for 8 miles to Middleton, and macadam, though old, through the town. All through farming country. See Essex County figures.

"In Windsor and Dalton, county of Berkshire, route from Northampton to Pittsfield. Estimated cost, $78,000. Main through route, Albany, N. Y., Pittsfield, Mass., Northampton, Springfield and Boston. All through farming country towns from 7 to 14 miles from railroad. The highway is their only outlet. One of 3 main routes east and west through the state. Northern route has heavy grades and is impassable in winter and spring.

"In Sandwich, county of Barnstable, route from Sandwich to Mashpee. Estimated cost, $20,000. This is the link connecting Sandwich village with Mashpee, Cotuit, Falmouth, etc. It runs through a farming community, rural mail route.

"In Cummington, county of Hampshire, on route from Northampton to Pittsfield. Estimated cost, $124,000. This is a continuation and completion of a bad stretch of road on main route. See Windsor. Most of the rest of the route is macadam or a fair gravel road. Completes this main route.

"In Athol and Petersham, Worcester County, route from Athol to Worcester. Estimated cost, $163,000. Main line, all through a farming country, from the city of Worcester to Athol. Main line in Worcester County from Athol, goes to New Hampshire and Vermont. Yearly value of agricultural products, Worcester County, $5,574,650—U. S. census, 1910.

"In Braintree, county of Norfolk, from Braintree to Quincy. Estimated cost, $45,000. This is on main line between Brockton, Mass., a very large manufacturing city (shoes) and Boston. Would be much used by trucks carrying leather, shoes, etc.

"In Littleton, county of Middlesex, from Littleton Common

to Groton. Estimated cost, $72,000. This is an uncompleted section on the main line from Boston to Keene, N. H. Practically the whole route in Massachusetts is macadam with a bituminous top or better, except for 7 miles in Littleton and Groton. Present road is a bad dirt road—impassable at times.

"In Saugus, county of Essex, on the route to Newburyport. Estimated cost, $90,000. This is another stretch and one of the worst on the Newburyport turnpike continuation of project No. 3, agreed to last year and 80% constructed. See Malden, Melrose and Saugus description."

New York

H. Eltinge Breed, First Deputy Commissioner, New York Commission of Highways, Albany, writes:

"With regard to our contemplated program this year, I would say that we have somewhat in the neighborhood of 1,100 miles of old contract work still in force. Of this amount 500 miles is physically completed and practically in use. Of the remaining 600 miles, about 300 miles are torn up and about 300 miles have had no work done upon them. It will be our aim this year to finish the work on the contracts that have been torn up complete with surfacing.

"Last year we built almost 400 miles of road, so from that estimate you can see that the 300 miles I said we hoped to complete will be about what we will actually get done this year, owing to present conditions.

"The completion of this work will involve the importation of about 500,000 tons of material, so that if one-half of it is completed, there will be car supply necessary for transporting about 250,000 tons. As some of this can probably be carried by motor truck, it will not mean quite the full car equipment that will be necessary to carry the 250,000 tons."

North Dakota

Jay W. Bliss, State Engineer, Bismarck, writes:

"The total mileage of the proposed state roads is approximately 42,000. It is the opinion of the State Highway Commission that a state highway system consisting of about 2,000 miles could have been developed more rapidly and would have been of almost equal service to the people of the state. However, the Highway Commission is of the further opinion that by paying special attention so far as is possible to the prior development of trunk lines excellent results will be obtained. I may say in this connection, however, that such state aid as is available in North Dakota is primarily for the purpose of placing the state in a position where it may benefit under the provisions of the Federal Road Act. This, together with the necessity of complying with the government requirements relative to post routes has placed the Highway Commission in many counties in an embarrassing position. The State Highway Commission has submitted a schedule to the Federal government covering 26 different projects in 20 different counties, and are preparing 6 more, which will be submitted in time for construction this year. While, under the conditions that exist in North Dakota, it has not been possible to secure projects, which in all instances are continuous, it is felt from a state-wide standpoint those selected are particularly fortunate in that in all instances the improvement of such roads will result in decreased cost in transportation of agricultural and other products, and in greater speed and reliability in the movement of such materials."

Ohio

H. D. Brunning, Chief Highway Engineer, State Highway Department, Columbus, writes:

"The Federal government has very promptly responded in the matter of approval of Federal aid projects which were presented to them by this department some time ago, and I believe that the Office of Public Roads is doing everything possible to help this department and the public in the consummation of the improvements contemplated for the season 1918. The projects approved by the Office of Public Roads in the order of their importance are as follows:

"First: National Road, I. C. H. No. 1, Muskingum County, Zanesville to New Concord, 13.63 miles. Estimated cost, $488,500.

"Second: Cleveland-Buffalo road, I. C. H. No. 2, Ashtabula County, Ashtabula to Conneaut, 11.93 miles. Estimated cost, $431,799.

"Third-A: Lincoln highway, I. C. H. No. 141, Ashland County, east of Ashland, 2.473 miles. Estimated cost, $68,000. Third-B: Lincoln highway, I. C. H. No. 141, Wayne County. From Jefferson village to Ashland County line, 6.71 miles. Estimated cost, $170,541.95. Third-C: Lincoln highway, I. C. H. No. 140, Richland County. From Ashland County line west 3½ miles. Estimated cost, $100,000.

"Fourth: Cleveland-Buffalo road, I. C. H. No. 2, Lake County, Painesville to Geneva, 13.17 miles. Estimated cost, $459,379.28.

"Fifth: Akron-Cleveland road, I. C. H. No. 16, Summit County. From Akron to Cuyahoga County line, 16½ miles. Estimated cost, $800,000.

"Sixth-A: National road, I. C. H. No. 1, Madison County. West Jefferson to Clark County line, 12.9 miles. Estimated cost not made. Sixth-B: National road, I. C. H. No. 1, Clark County, 2½ miles east of Springfield to Madison County, 9.28 miles. Estimated cost not made.

"Seventh: River road, I. C. H. No. 51, Lucas County. Maumee to Waterville, 8.21 miles. Estimated cost, $167,200.

"Eighth: Columbus-Wooster road, I. C. H. No. 24, Ashland County. Loudonville south, 1.542 miles. Estimated cost, $46,500.

"Ninth-A: Columbus-Wooster road, I. C. H. No. 24, Knox County. Mt. Vernon to Amity, 4 miles. Estimated cost, $163,893.40. Ninth-B: Columbus-Wooster road, I. C. H. No. 24, Knox County. Mt. Vernon south, 2 miles. Estimated cost, $65,289.13.

"Tenth: Cleveland-Wooster road, I. C. H. No. 25, Wayne County. Jackson to Bloomington, 5 miles. Estimated cost, $140,662.50.

"Eleventh: Bryan-Edgerton road, I. C. H. No. 309, and Bryan-Wauseon road, I. C. H. No. 297, Williams County. Edgerton west to Indiana state line and from Fulton County line west about 6 miles, in all a length of 8.75 miles. Estimated cost, $215,000.

"Twelfth: Milford-Chillicothe road, I. C. H. Nos. 9 and 258, Highland County, 22½ miles. Estimated cost, $347,000.

"Thirteenth: Cambridge-Caldwell road, I. C. H. No. 353, Guernsey County. Byesville south to 2.33 miles. Estimated cost, $92,384.44.

"Of the above, Nos. 1, 3-A, 7 and 8, have been placed under contract and work is in progress on same."

Oklahoma

Max L. Cunningham, State Engineer, Oklahoma City, writes:

"I have recommended to the authorities at Washington the construction of five projects, as follows:

"Project No. 1: A bridge across the South Canadian River, about 10 miles south of Oklahoma City.

"Project No. 2: A road about 25 miles long, leading into the town of Broken Bow, McCurtain County, Oklahoma, from a rich agricultural district to the northwest of that county.

"Project No. 3: A road running east from Oklahoma City, past the State Capitol Building, which is now part of a motor truck route.

"Project No. 4: A road from the city of Lawton, Oklahoma, to Camp Doniphan and Fort Sill, where connection is made with the roads within the military reservation.

"Project No. 5: A road about 16 miles long, from the city of Durant, Okla., to the north line of Bryan County, which will relieve the M., K. & T. Ry. of heavy local freight movements, by fostering the use of motor trucks.

"The state, in addition to the Federal government fund and

the full appropriation made to meet same, is expending the sum of $1,000,000 as a state aid fund to counties on the construction of permanent features on state roads in each county and is expended only in connection with an appropriation in equal amount made by the counties."

South Carolina

F. H. Murray, Acting State Highway Engineer, Columbia, writes:

"Herewith is a short statement relative to the schedule forms sent us by the U. S. Office of Public Roads in regard to proposed Federal aid projects for this year in South Carolina:

"At a recent meeting of the South Carolina State Highway Commission estimates were approved for Federal aid work in a number of counties.

"In order to arrive at a tentative program for 1918 Federal aid work in the counties, the commission recently submitted to the United States Office of Public Roads in Washington for its approval the following schedule of Federal aid projects. The United States Office of Public Roads has tentatively approved of the expenditure of the amounts shown below on these projects. Several of these counties have complied with the conditions of the Federal Aid Act by supplementing the amount of their apportionments.

"The counties listed below have all filed with the State Highway Commission written application requesting their apportionment; however, several of them have not yet arranged to supplement these funds.

"It is worthy of note that the projects listed below may all be considered of military value, as they assist in bringing produce to market and shipping centers. The first three projects listed are for roads leading to cantonments:

County	F. A. Funds
Richland (for road to cantonment)	$23,248.20
Spartanburg (for road to cantonment)	48,577.87
Greenville (for road to cantonment)	20,000.00
York (for road)	18,378.84
Chesterfield (for road)	5,570.93
Union (for bridge)	10,881.06
Chester (for bridge)	10,881.06
Horry (for bridge)	2,500.00
Marion (for bridge)	13,183.88
McCormick (for road)	11,201.99
Cherokee (for road)	16,802.99
Horry (for road)	16,284.88
Chester (for road)	12,600.04
Bamberg (for road)	10,771.14
Pickens (for road)	14,648.76
Newberry (for road)	19,129.55
Edgefield (for road)	12,322.19

"Projects in Greenville and Spartanburg Counties for roads leading to Camp Sevier and Camp Wadsworth are now under construction and it is proposed to start construction of several additional projects in the near future."

Texas

George A. Duren, State Highway Engineer, Austin, writes:

"Herewith is an abstract giving the mileage and total estimated cost of all the Federal aid projects in Texas:

Con. Order No.	Mileage	Total Est. Cost
1. Hays	24.8	$43,131.00
2. Travis	6.0	25,389.10
3. Dallas	1.0	20,000.00
4. Wichita	8.9	87,737.10
5. Harris	3.2	113,221.22
6. Bexar	18.18	110,080.76
7. Williamson	21.5	106,375.50
8. McLennan	3.5	25,000.00
9. McLennan	3.0	25,000.00
10. McLennan	1.25	10,000.00
11. Harris	4.6	48,592.00
12. Johnson	33.89	89,365.00
13. Lee	6.35	20,000.00
14. Ward	17.5	26,141.50
15. Brooks	20.0	42,077.75
16. Culberson	50.4	45,256.55
17. Caldwell	15.8	77,120.00
18. Fayette	11.0	73,546.00
19. Titus	8.0	56,040.00
20. Titus	11.25	19,800.00
21. Dallas	3.0	20,000.00
22. Dallas	3.0	14,000.00
23. Dallas	3.0	20,400.00
24. Morris	10.88	65,200.00
25. Tarrant	10.0	68,740.00
26. Shackelford	9.0	29,956.00
27. Dickens	6.5	32,439.00
28. Wharton	3.3	23,526.70
29. Franklin	12.15	49,500.00
30. Eastland	28.3	110,145.20
31. Guadalupe	15.7	69,789.56
32. Robertson	5.5	27,990.50
33. Madison	21.8	87,500.00
34. McCulloch	37.4	75,774.60
35. Tarrant	6.2	28,619.25
36. Tarrant	3.2	24,343.00
37. Walker	5.3	14,341.80
38. Val Verde	4.9	27,000.00
39. Jasper	13.6	71,696.90
40. Gregg	14.6	40,500.40
41. Mason	24.9	22,533.50
42. Wise	42.3	170,000.00
43. Mitchell	7.5	25,867.60
44. Bell	36.93	100,000.00
45. Lamar	5.0	20,000.00
46. Lamar	6.0	24,000.00
47. Gillespie	18.6	41,899.00
48. Hemphill	17.0	19,646.00
49. Collingsworth	8.0	10,010.00
50. Coke	18.65	44,836.00
51. Nolan	13.7	43,973.00
52. Bosque	59.2	237,208.81
53. Callahan	12.1	50,453.70
54. Jefferson	5.4	89,968.00
55. Camp	8.0	69,816.00
56. Jefferson	5.6	94,237.00
57. Wilbarger	4.66	97,136.00
58. Navarro	11.8	133,102.00
59. Calhoun	10.0	23,594.00
60. Randall	19.0	24,766.56
	821.79	$3,308,383.56

"Average cost per mile, $4,025.82."

Wyoming

Z. E. Sevison, State Highway Engineer, Cheyenne, writes under date of April 4, as follows:

"In regard to our report on essential highways for 1918 construction, this report was sent to Washington last month and I have been advised by the director of the Office of Public Roads that our program for this year has been approved without exception.

"This program of Federal aid in Wyoming includes 15 projects, for which the estimated cost is approximately $600,000. The plans for 14 of these projects have been completed and submitted to the Office of Public Roads. Four sets of plans have been approved to date and one project is now being advertised. It is believed that all of these plans will be approved not later than April 15th.

"Surveys for one project in Sheridan County, consisting of 8 miles of hard surfaced road, are now being made, the esti-

mated cost of this project being $200,000, and it is expected that the project will be completed this year.

"The state aid work is limited on account of the small amount of state funds available for work of this kind. However, the funds have been apportioned to the various counties and a program agreed upon in nearly all of the counties. This work consists principally of bridges, but in some cases the work will be on construction on the Lincoln highway and the Yellowstone highway.

"The work being done independently by the counties does not come under this office and we have no means of knowing just what will be done, but it will be of practically the same class of work as is usually done by local authorities, which is simply patchwork here and there, with no really permanent construction.

"The counties will probably spend about $400,000 in the state this year for this class of work."

Iowa

Thos. H. MacDonald, Chief Engineer, Iowa State Highway Commission, Ames, writes:

"Concerning our federal aid projects, I will say that the projects which the commission has under way for this year have been approved by the Federal Department, and involve the building of the following roads:

Earth roads	238.6	miles
Gravel roads	107.7	miles
Concrete roads	5.07	miles
Brick or concrete	3.3	miles

Chicago Awards Paving Contracts Aggregating Over $800,000 and Expects Normal Paving Year

Prospects are that Chicago will spend a normal amount of money for street pavement construction this year in spite of the war. On April 3, 1918, bids were opened for the first letting of the year. This letting covered 15 miles of pavements and the bids of the successful bidders aggregated $803,759.80.

In addition to this work, approximately 28 miles of special assessment paving contracts, aggregating $1,612,580, carried over from previous years, will be executed this year. Virtually, this entire sum is for work just started which will be done this season.

Other street improvement work for which special assessments have been confirmed and which Chicago is ready to receive bids on, aggregates about 20 miles.

Since the first of October, 1917, to the middle of April, this year, there were filed with the special assessment department of the board of local improvements over 500 preliminary pavement estimates.

Contracts Awarded at First Letting

Among the successful bidders at the big letting held on April 3, when over $800,000 worth of contracts were awarded, are: The Ryan Company, Smith & Brown Company, the American Asphalt Paving Company, Ready & Callaghan Coal Company, R. F. Conway Company, Contracting & Material Company, Calumet Coal & Teaming Company, Citizens' Construction Company, James A. Sackley Company, Marquette Construction Company and Farr Brothers Company. Some of the biggest street paving contractors in Chicago are represented in this list.

The types of paving covered in these awards are: Creosoted wood block on 1-in. of Portland cement mortar and 6-in. of Portland cement concrete, joints filled with coal tar, surface dressed with ¼ in. of torpedo sand; vitrified paving brick on 1 in. of Portland cement mortar and 6 ins. of Portland cement concrete, joints filled with asphaltic filler, surface dressed with ¼ in. of sand; asphalt on 6 ins. of Portland cement concrete, swept with natural hydranlic cement; 2½ ins. of granite or trap rock bonded with asphaltic cement; 8 ins. of blast furnace slag or 8 ins. of limestone and 2¼ ins. of limestone bonded with asphaltic cement, top dressed with ¼ in. granite screenings; granite blocks on 2 ins. of sand and 6 ins. of Portland cement concrete, joints filled with gravel and coal tar, surface dressed with ¼ in. of gravel.

M. J. Faherty, President of the Board of Local Improvements, believes firmly in the economic importance of public improvements and is going ahead with the work.

General Articles

Construction Methods and Equipment Employed in Construction of Suburban Telephone Conduits

A telephone company operating in one of the largest cities of the country and in the contiguous suburban territory has an especially alert and progressive construction department in its suburban plant division. The data here presented are drawn from the experience and observation of the superintendent of construction of the suburban plant division, and their authenticity is vouched for by the editor of Municipal Engineering.

Trenching

The company had two important pieces of suburban conduit construction in 1917; both were rush jobs. It was decided to use a trenching machine, so the company purchased a Type 122, Pawling & Harnischfeger excavator at a cost, delivered, of $3,277. The machine was placed in operation on April 27, 1917. The total amount of conduit constructed was 61,000 trench feet; the machine was used on 54,000 trench feet. The maximum cut was 5 ft. 6 ins. and the average cut 3 ft. 6 ins. The trench width was 15 ins.

On the first job the soil was two-thirds blue clay and one-third black dirt. There was some solid rock, some gravel and boulders encountered. On this job there was much rain and one cyclone.

On the second job the soil was one-third gravel and two-thirds light earth, with a considerable quantity of large boulders. Ideal weather conditions prevailed. Each job took about two months, the second immediately following the first.

The superintendent states that this excavating machine will operate efficiently, except in rock, in very wet, heavy, black soil that gums the buckets, and in heavy gravel, where there are many boulders exceeding 10 ins. in diameter.

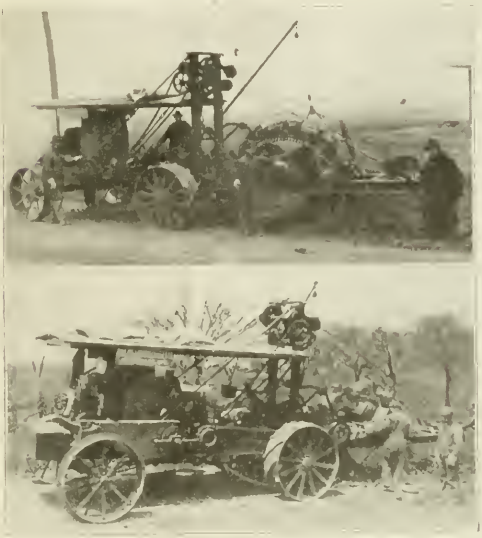
On the work here described soil overlying rock was stripped off by the machine. The rock was then drilled and blasted as later described.

The maximum length of trench dug in a day of 10 hours was 1,695 lineal ft. The average was 832 trench ft. per day, *counting in all the bad days.* The machine can average 150 ft. per hour in a trench 15 ins. wide and 3 ft. 6 ins. deep.

The superintendent, who represents a great and conservative company satisfied with nothing short of the best work obtainable, recommends the overhauling of the machine after

every five miles of trenching. The cost of this overhauling, he finds to be about $175 on the average and it requires three days' time. If this is done, the machine has a useful life of 150 miles of trench.

On this suburban work it is necessary to keep to the side of the road. The machine can be used on a slope by blocking up the wheels on one side as much as 3 ft. The blocking is done with 3x12-in. maple planks. Naturally unusual care must be exercised in operating the machine on this country roadside work and the speed of operation is correspondingly reduced.



VIEWS OF TYPE 122 PAWLING & HARNISCHFEGER TRENCH EXCAVATOR DIGGING TRENCH FOR SUBURBAN TELEPHONE CONDUITS.

The machine trench was successfully cut for a length of two miles across gas service connections into every house. Where the location of a service was known the excavating wheel was raised and the service cut by the gas company. Some services were struck and broken without damage to the machine. The machine has a dependable slip clutch system for stopping when solid rock or other relatively immovable obstacle is struck. The superintendent says the machine is of very strong construction. It was moved 6 ins. laterally without damage in a cyclone.

This machine can move from one job to another over country roads at the rate of 1½ miles per hour. On this work it was so run for a distance as great as 20 miles between jobs. On such runs the cleats should be removed from the wheels. In cross-country running contractors should watch the bridges and culverts, shoring them up where necessary, as the machine naturally is heavy.

A statement of the daily operating expense of this machine on the work here described, done in 1917, follows:

Item	Cost
20 gals. of gas at 20 cts.	$4.00
2 gals. of oil at 45 cts.	.90
Engineer's salary and board	6.00
Helper (watched oiling, tension on belts, helped raise and lower wheel, relieved engineer, etc.	3.50
2 laborers blocking wheels and removing boulders or cleaning mud from buckets at $3.50	7.00
10 men to trim up trench on bottom to rigid line and grade at $3.50	35.00
Depreciation, basis 150-mile life	3.32
Interest on investment	1.66
Repairs	6.65
Total daily operating expenses for 832 trench ft., av.	$68.03
Average cost per trench ft., 8 cts.	

Hand labor for same work would cost 25 to 30 cts. per trench foot at same wage scale.

The superintendent says that the machine saved his company $10,500 on these two jobs and would have saved much more, but for the extreme care exercised in cutting the trench to a mathematically exact line and grade. It also made a big indirect saving of time and money by avoiding the labor troubles which surely would have been experienced had all hand labor been used.

The superintendent gives it as his judgment, based on experience, that this machine will cut trenches of this depth and difficulty at a cost of 1 to 2 cts. per trench foot under most favorable conditions in good soil and where it is unnecessary to adhere to exact line and grade. He considers the machine particularly well adapted for cross-country pipe mains, and for trenching for light gas and water mains, wherever other

VIEWS SHOWING CONSTRUCTION OF TELEPHONE CONDUIT IN SUBURBAN DISTRICT.
Left: Machine Excavated Trench. Right: Mortar Patch at Joints and Concrete Around the Four-Duct Vitrified Clay Conduit.

mains are not in the way, up to a trench depth of 6 ft. and width of 21 ins.

Design of the Conduit

The conduit was laid with 4-duct, vitrified clay tile, made by the Clay Products Co. of Brazil, Ind. The sections were 10x10 ins. and 3 ft. long. In dry ground and under light traffic, the tile was laid without a concrete base, but with a 3-in. concrete covering. In wet soil the tile was laid on a concrete base 4 ins. thick and was covered with a 3-in. layer of concrete, earth being tamped in at the sides of the tile. Where the traffic across the line of the conduit was very heavy, or where it passed under a railroad track, 4 ins. of concrete was placed entirely around the tile. The concrete was all mixed in machines. On this work manholes were spaced at about 500-ft. intervals. They were mostly of brick, but some were of concrete. The company would have used more concrete manholes, but could not develop a satisfactory knock-down form. There is a good form on the market, but the superintendent considers it very expensive.

Backfilling the Trench

In backfilling a machine was used, one that was on hand from a previous season. This machine was of the "Double Quick" type and cost $477 laid down. In operation this machine, made by the Waterloo Cement Machinery Corporation, requires an engineer and 2 men on the sweep. The itemized daily expense of operating this backfiller was observed as follows:

Item	Cost
Depreciation, 600 days' life	$0.80
Interest on investment	.28
Oil, gas and repairs	3.00
3 men (1 engineer, 2 laborers)	11.00
Total	$15.08

This machine displaced daily $27.50 worth of teams and scrapers (6 men and 2 teams). This was a saving of $12.42 per day at the rate of 1,000 ft. of trench backfilled per day. This machine is also found useful in the winter for pulling cable and on other work for which a winch is needed.

In discussing backfilling equipment, the superintendent referred colloquially to the P. & H. one-man backfiller as a "peach." He says it is strictly a one-man machine. It is a great machine where sufficient road clearance is available, but could not be used on this work, as the telephone company was not allowed to obstruct the road at all.

The backfill was not tamped by machine as this was unnecessary on this country road work. The backfilled earth was crowned to a height of 2 ft. over the trench where it was left for a time for the rains to settle. After this natural settlement had about run its course a 4-horse road roller was rented and run over the trench two or three times when the earth over the trench was nearly level again. Men followed the roller to fill in the low spots by hand. Two months after the completion of this work the line of the trench could not be traced on the ground.

The superintendent says the power tamping machine is the thing where it is necessary to repave safely over a new trench. He has used one of P. & H. manufacture on his city work at street crossings of his conduits and finds that the dirt can be put back as hard as concrete. He finds this machine useful also in cutting asphalt, where it works safely and economically. It is also serviceable for breaking up concrete pavement base. It was his experience that this machine will replace 10 good hand tampers.

Rock Drilling

On the trenching work where ledge rock was encountered the overburden was first removed with the trenching machine and the rock was then drilled and blasted. For the drilling a portable air compressor and rock drill was used. It was manufactured by the Zin-Ho Mfg. Co. of Chicago. It is size 42, and is driven by a 4-cylinder, 15-h.p. gas engine. The outfit comprised: Air compressor, drill head, drills, hose, housing, etc., and cost about $1,300. The cost of running this machine was $8 per day, including depreciation and all overhead charges. The superintendent said that the cost of drilling a 1-in. hole by hand to a depth of 24 ins. was $1.50 and by machine 50 cts. On one of the jobs here described this machine saved $1,200 and on the other $300.

This machine was used for setting telephone poles in rock as well as for drilling blast holes in rock trenching. It was also used to set a 500-gal. gas tank in solid rock at a saving over hand labor of $150. It was found useful, incidentally, in blowing up pneumatic tires. The superintendent said of this machine: "It is the goods. It will shoot the holes down in a hurry."

The accompanying illustrations show two views of the trenching machine and two views of the trench and conduit under construction.

Coming Conventions

WAR CONVENTION OF MACHINERY, TOOL AND SUPPLY INDUSTRY—This convention will be held in Cleveland, O., the week of May 13. It will be a joint war convention of four large national associations, namely, the American Supply and Machinery Manufacturers' Association, the National Supply and Machinery Dealers' Association, the Southern Supply and Machinery Dealers' Association and the National Pipe and Supplies Association.

AMERICAN WATER WORKS ASSOCIATION—Annual convention at St. Louis, Mo., May 13-17. Secretary, J. M. Diven, 47 State street, Troy, N. Y.

AMERICAN ASSOCIATION OF ENGINEERS—Annual meeting at Chicago, May 14. Headquarters at 29 South La Salle street, Chicago.

ALABAMA GOOD ROADS ASSOCIATION—Annual convention at Mobile, Ala., May 14-17. Secretary, J. A. Rountree, 1021 Brown-Marx Building, Birmingham, Ala.

ARKANSAS ASSOCIATION OF PUBLIC UTILITY OPERATORS—Annual convention at Hot Springs, Ark., May 21-23.

Personal Items

John W. Alvord, consulting engineer, of the firm of Alvord & Burdick, of Chicago, has been chosen consulting engineer to serve with Frederick Law Olmsted, city planner of Boston, and Burt L. Fenner, of McKim, Mead & White, the New York architects, to advise the Federal Department of Labor in connection with the housing program, which will involve an expenditure of more than $60,000,000.

R. A. Meeker, formerly state highway engineer of New Jersey, has opened offices as a consulting engineer in Newark, N. J.

Charles Bradford, who has been connected with the work of the office of the engineer of Snowhomish county, Washington, with headquarters at Everett, for the past five years, has resigned that position to take another with the Washington Paving Company, of Seattle. He will serve the latter company as superintendent of paving.

H. G. Shirley, formerly chief engineer of the State Roads Commission of Maryland, with offices in the Garrett Building, Baltimore, resigned that position to accept the position of executive secretary of the Highway Industries Association. He was succeeded as chief engineer on April 15 by J. N. Mackall.

William H. Collison, Jr., has been appointed city engineer of Ocean City, N. J., to succeed Morgan Hand, Jr., who resigned the office.

R. C. Harvey has been appointed city engineer of Kent, O.

F. W. Simonds has been appointed city engineer of Rahway, N. J.

EDITORIALS

Fundamental Changes Favorable to Construction

Many people outside the construction industries are beginning to realize that the present attitude toward public works cannot long continue. Those who ride in passenger automobiles, for example, are learning the results of postponing street repairs. In many localities roads and streets once a delight to the motorist are rapidly falling into such bad condition as to make their use more painful than pleasureable. The people are becoming somewhat restless because of this fact. Even the least discerning are heard to remark that many streets, if not soon repaired, will require reconstruction by next year. There is no question that hearty popular approval would be granted even now to a spirited revival of new road and street construction, to say nothing of the resumption of adequate maintenance of existing thoroughfares.

City officials seem somewhat less sure of the wisdom of postponing improvements until after the war than they have been in recent months. The end of the war seems far away, since it has become clear that a military decision must be reached before peace can come. The negotiated peace is not in favor. Germany must be defeated by force of arms and the fight will still be long, though the result no American for one moment doubts. Many officials who looked with favor on postponing improvements "for the present" are not willing to adopt this as a policy to be observed for a period that may last two or three years. They are beginning to count the cost, not of making improvements, but of the failure to make them at the right time. It is becoming better understood that such improvements as have normally been made in this country for many decades cannot be postponed indefinitely without serious economic loss and unnecessarily serious dislocation to the habits and customs of the people.

Those who favored curtailing construction because of present high costs are beginning to realize that these costs will remain as high after the war, perhaps for five or ten years, as they are now. The natural result of this conclusion, based on old experiences, recently rediscovered, will be a demand for the early resumption of construction work.

Generally speaking, people are beginning to realize, also, that not more than five or ten per cent. of our population is likely to become at all actively engaged in waging the war and not more than an equal number will be engaged in war work at home. All the rest of us, say at least eighty per cent. of the total population, must go on working from day to day, making a living and earning the money to buy Liberty Bonds and to subscribe for various other war purposes. It is only natural that people should want to do the kind of work they have always done and to live, so far as possible, as they have always lived. Under such circumstances they would do cheerfully the civilian's duty in the war, though it should last for twenty years. But if one line of business after another is made impossible, by government orders, winning the war is going to be made needlessly difficult for everybody.

The question is one of judgment, not one of narrow self-interest or of patriotism. We all approve of patriotism in the abstract, but have a right to scrutinize the measures advanced in its name. Every man has a right to speak up for his business. Engineers, contractors and others who have lived by serving the public in the design and construction of public works have every right to urge that the work they are best fitted to perform should now be resumed. The industrial mix-up, caused by our belated and feverish efforts to untangle our military arms and legs, is gradually straightening out, and there are now more and better reasons for resuming construction work than to continue the policy of postponement. Good observers have reached this conclusion who are above the suspicion of selfishness. When the Chamber of Commerce of the United States advocates the resumption of road building there is no longer an excuse for the failure of engineers and contractors to do the same. Letters should be written to local newspapers arguing for the resumption of construction; if this is done, public opinion will soon do the rest.

In a recent editorial, entitled "Crushing Business," the Western Banker and Financier said:

> If all business other than making of munitions of war, and food supplies and ships, is to cease, then it follows that only those who are employed in the occupations mentioned will have an income, and the rest of the population will have to depend upon them for a living. We are told, for instance, not to build any houses. What, may we ask, are the men who would be engaged in building to do for a living? They are not all needed in shipbuilding, because many of the occupations have no connection with ships; they are not needed in other directions, for the manufacture of war material, because that is being rushed to the limit. If the men were allowed to work at the occupations for which they are best fitted and could earn good wages, would they not be far better able to become bond buyers than if their occupation is taken from them?

These are pertinent questions. That such questions are being heard on every side is distinct cause for encouragement. Fundamental conditions are becoming more sound, and the prospect of an early return of something approximating normal business conditions is good.

Some of these fundamental changes in the official and popular points of view are directly favorable to the resumption of construction, while others are only indirectly so, since they are general, applying equally well to all legitimate business. Among the conditions beneficial to all business should be mentioned the better understanding recently reached between administration and big business leaders. The appointment of such men as Schwab, Ryan and Stettinius to important war posts is significant and has undoubtedly done much to stabilize business conditions. A settled policy in the war, "force without limit," has also greatly clarified the situation. Because of its definiteness this is an ideal working program. The period of errors and experiments is closing, and that of quantity production is beginning. That all business is due for early improvement seems most probable.

Standard Construction Methods

Much has been done by engineers to standardize specifications prepared to govern construction and also to standardize the broad essential features, and even the principal details, of engineering designs. Engineering literature is rich in matter relating to standard specifications and designs, but it is all too barren of matter relating to standard construction methods. Undoubtedly this is due, in part, to the fact that local conditions are supposed to govern the choice of construction methods. Within limits this is true, but the range of local conditions is not indefinite in extent, and the construction aspects of one job are very much like those of another involving the same materials of construction employed for the same ultimate purpose.

The meagerness of literature tending to standardize construction procedure is also due to the fact that contractors are disinclined to describe their work for the benefit of the other man. If contractors would publish descriptions of the construction plant and methods and the organization of forces they have found best suited to various types of construction work, we should soon have as much literature on standard construction methods as we now have on standard specifications and designs.

That contractors, with important exceptions, will do nothing of the kind is only too well understood. Admitting the need of more literature on construction methods, the engineer must supply it. A striking example of what engineers can do in this connection, if they will, is presented in this issue in the article on standard methods employed in building sewers in Chicago. That article will be read, and doubtless will be preserved for many years, by thousands of contractors and engineers. It is one of the best sewer construction articles ever published.

An interesting side light on the psychology of the contractor may be pointed out to the readers of Mr. Hudson's splendid article. It is likely that more than one contractor will at first feel, on reading the article, that his personal, private, individual stock in trade has been discovered and presented to the world. As a matter of fact, the standard methods described have been developed and uniformly employed by several of the leading Chicago sewer contractors over a period of years. Methods, plant and organization of forces are identical in the practice of these contractors.

This is often the case. Contractors in direct competition employ the same instrumentalities and each contractor lives in fear that his competitors will learn his methods (which they already know, of course). Thus he regards his procedure as his stock in trade and does not encourage publicity about his methods, plant and organization. The only men who could use this knowledge to his disadvantage already possess it, but his attitude denies the benefit of this knowledge to men who never compete with him—men in other parts of the country.

In those rare, futile moments when we indulge in longings wild and vain, we wish contractors would change their attitude toward publicity and help standardize construction methods. But we hope engineers will not wait for this wholesome and regenerating change to occur. Engineers will have to take the lead in this matter, and the sooner they do it the better for all concerned—including, of course, the contractors.

Stress the Word Engineering

In the name of this publication there are two words: Municipal and Engineering. Some see one word, some the other; many see both. Those who see but one word are implored to concentrate their vision on the word engineering, as this is an engineering, not a municipal, publication.

There is really no accounting for the tendency to read into a title what is not there and to read out of it what clearly is there. But much is to be gained by calling attention to the true meaning and proper interpretation of a title. In this case those who stress the word municipal and slur the word engineering get an entirely wrong idea of this publication and of the purpose and scope of its editorial contents.

We are moved to make these observations because just recently an article was tendered describing how the merchants of a Wisconsin town got together and decided to devote a certain percentage of their annual gross receipts to the purchase of Liberty Bonds, for contributions to the Y. M. C. A. and Red Cross funds, etc., and then to turn a deaf ear to all appeals. Now that might be called a municipal activity, but it certainly could not be called engineering. Another man thought to interest us with a letter telling of the building in one day of a Liberty Temple solely for war purposes. These things are of interest to all citizens, yes, but not to engineers as engineers. Such articles, therefore, do not belong in MUNICIPAL ENGINEERING. Why not submit them to The Journeyman Barber, The Lumberjacks' Gazette or The Butterine Vindicator? This is an engineering paper—get that point.

Do not draw inferences; analyze instead. Note the sub-title of this publication: The Design, Construction, Operation and Maintenance of All Public Works. Note the titles of its leading editorial sections: Pavement Design and Construction; Sewer Design and Construction; Water Works Design and Construction; Water Works Maintenance and Operation; Water Purification and Sewage Treatment; Drainage and Irrigation; Bridges and Buildings; Advance Information on Big Jobs, etc. No one is justified in concluding that a publication with such editorial contents is edited for any others than engineers, contractors and plant superintendents.

It naturally follows that those who really know this publication—that is, its regular readers—are: Engineers who draw plans and specifications and supervise construction work, contractors who build the works, and superintendents and managers who operate the works. This leaves out all such as are interested in civic betterment, community nursing, fly swatting, municipal markets, municipal Christmas trees, etc. Our waste circulation is, consequently, the absolute minimum. Subscriptions from those who haven't a legitimate, business interest in our technical editorial contents are declined. Offers of blocks of non-technical subscribers, with but a faint and fleeting interest in engineering matters, are most undesirable. The non-technical find nothing of interest in MUNICIPAL ENGINEERING, unless they expect to become students of technical matters. The spring crop of aldermen would better patronize the ball parks than subscribe for this publication, unless they intend to familiarize themselves with at least the broad aspects of engineering work in cities.

PAVEMENT DESIGN AND CONSTRUCTION

Asphaltic and Non-Asphaltic Road-Oil Specifications

By J. W. Howard, Consulting and Testing Engineer on Roads and Pavements, 1 Broadway, New York City

Many existing macadam, gravel, slag and similar roads, whether or not previously treated with road-oil impregnating them to a reasonable depth, can be repaired to grade with new material similar to the old road material, and then so treated with an application of road oil as to thus cheaply and quickly be put in good viable condition, especially in these war times, when entire reconstruction or resurfacing with more durable materials is not always possible from lack of funds.

Big Demand for Specifications

There being a large demand for standard specifications for asphaltic road oil and for non-asphaltic road oil, I have prepared the following two sets of specifications, based on long experience. Each of the several tests has a direct practical relation to the qualities which each kind of road oil should have to give the best possible results when properly applied in dry weather of a temperature above 70 degs. F. and when the road surface is free from moisture. Superfluous tests and alleged tests which are non-essential, peculiarities of single products or brands, are properly omitted, to combat commercial promotion and monopoly. The other requirements for preparation of the road surface and the application of oils and how to apply a thin layer of fine crushed stone screenings or coarse sand, especially over the asphaltic oil after its application and after several hours in warm weather or over night have been allowed for the oil to penetrate the road, are known to engineers familiar with road construction, and those other requirements are in the rest of the specifications for construction, etc.

These two sets of specifications for qualities of two types of road oils are each suited to many roads, but in many cases the asphaltic road oil is best and in the end more economical to be used, because of its more lasting qualities, and permit competition from the many road oils of good qualities of both types available throughout the United States and Canada.

General Requirements for All Road Oils

These specifications constitute a part of the contract.

The oil must be in all respects suitable for the purpose and subject to the approval of the engineer and must comply with the following requirements or tests:

The contractor must be properly equipped to apply the oil in accordance with the specifications, at the rate of at least 2,000 gals. per working day.

The contractor will apply the oil evenly with a vertical spray gravity sprinkler or with a pressure distributor or otherwise, as approved by the engineer.

A sample or samples of the oil must be submitted by each bidder with his bid, of the kind or kinds of oil he will use if the contract is awarded to him, and the oils subsequently used must conform to the quality required by these specifications. The samples must be of at least one pint each and delivered in cans (not glass) clearly marked with name and address of bidder, place and date of bidding.

Specification for Asphaltic Road Oil

1. Character of oil must be.....Asphaltic
2. Specific gravity at 60 degs. F.....At least 0.915
3. Per cent. of asphalt content, determined by the following test, shall be.....At least 50%

   The asphalt content shall be that portion of the oil which remains and has a consistency or penetration of 100 (1 centimeter) at 77 degs. F., with No. 2 standard needle, under 100 grams weight, in 5 seconds, after heating in air not to exceed 500 degs. F., until the asphalt residue of penetration 100 is obtained.
4. Flash point (open crucible).....At least 175 degs. F.
5. Solubility in carbon disulphide (moisture not exceeding 0.5% excluded), purity.....At least 99.5%
6. Solubility in 76 degs. Beaume naphtha...Not exceed 90%
7. Character of residue (freed from naphtha) after test 6 .....Must be sticky
8. Water present .....Not exceed 0.5%
9. Loss 20 grams (fresh sample) at 212 degs. F., 1 hour .....Not exceed 5%
10. Loss 20 grams (fresh sample) at 325 degs. F., 5 hours .....Not exceed 25%
11. Character of residue after test 10 must be..Soft and sticky

Specification for Non-Asphaltic Road Oil

1. Character of oil must be.....Non-asphaltic
2. Specific gravity at 60 degs. F.....At least 0.86
3. Viscosity (Engler 50 c.c.) at 100 degs. F..... .....Not faster than 25 secs.
4. Flash point (open crucible).....Not less than 300 degs. F.
5. Solubility in carbon disulphide (moisture excluded), purity .....At least 99.5%
6. Solubility in 76 degs. Beaume naphtha.....At least 99.5%
7. Character of residue (freed from naphtha) after test 6 .....Must be oily
8. Water present.....Not exceed 0.5%
9. Loss 20 grams (fresh sample) at 212 degs. F., 1 hour .....Not exceed 5%
10. Loss 20 grams (fresh sample) at 325 degs. F., 5 hours .....Not exceed 20%
11. Character of residue after test 10 must be.....Fluid

Note.—The engineer will cross out the specifications of the type of oil not required for each specific contract or work.

Data on California Asphalt Paving Work Performed with Portable Asphalt Plant

By T. E. Stanton, Assistant Division Engineer, California Highway Commission, Sacramento, Cal.

The data here given pertain to Topeka surfacing placed on the wooden trestles on the Upper Stockton road. The work was done in the winter of 1916, under very trying conditions, with a small, portable asphalt plant of the Bacon type.

In repairing the old stringers and floor an attempt was made to give a crown to the flooring by dapping the stringers. Owing to the condition of the old floor plank used, which was full thickness at the ends and worn thin in the middle, also to the fact that on some of the bridges, where, on account of using all old stringers, it was impracticable to give a crown to the wooden floor, the average thickness, instead of being 2 in. as intended, is practically 3 in., or 2⅞ in., to be exact. In some places the thickness is in excess of 4 in. in the center. Wherever this condition occurs (except on one bridge) coarse rock was used in the bottom course.

Except on one short bridge (the first laid), all pavement was laid in two courses, in order to prevent cracking on account of spring in the planks. It was also found necessary to

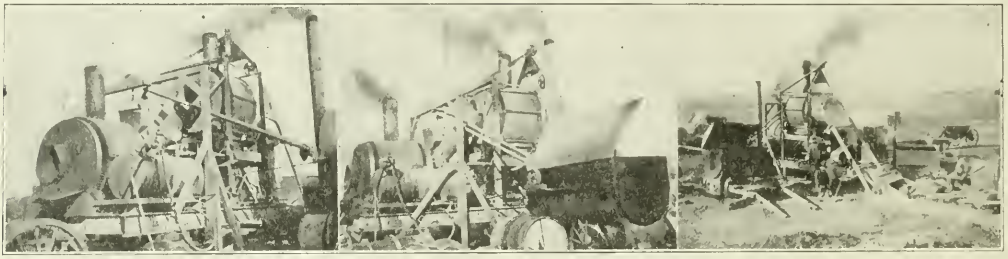
use a light 2½-ton roller instead of a 5-ton roller. The work was commenced November 19, 1915, and finished February 19, 1916, so that we were working throughout the winter rains, and were able to work only a little over one-half of the time.

The sand and screenings were continually soaked with water, and it frequently required from 15 to 20, and sometimes 25, minutes to dry out and heat up a batch to the required temperature.

The total number of 1,070-lb. batches turned out was 2,473; hours worked, 460¼, or 1 batch every 11.2 minutes on the average. The plant was therefore worked sufficient time to have turned out five or six times the amount actually laid within the period operated. With the exception of one burned-out firebox, which was repaired at a cost of about $30, the plant finished in good condition.

Bitumen	Spec. %	From Quantity Used	From Lab. Tests
	7.5—10	9.5	9.50
Mesh No. 200	8 —13	10.9	8.25
Mesh No. 80	14 —15	Sand	20.56
Mesh No. 40	17 —19	48.9	25.73
Mesh No. 10	5 —11	Screen	10.41
Mesh No. ¼	15 —25	30.7	13.44
Mesh No. ½	3 —10		12.11
		100.0	100.00

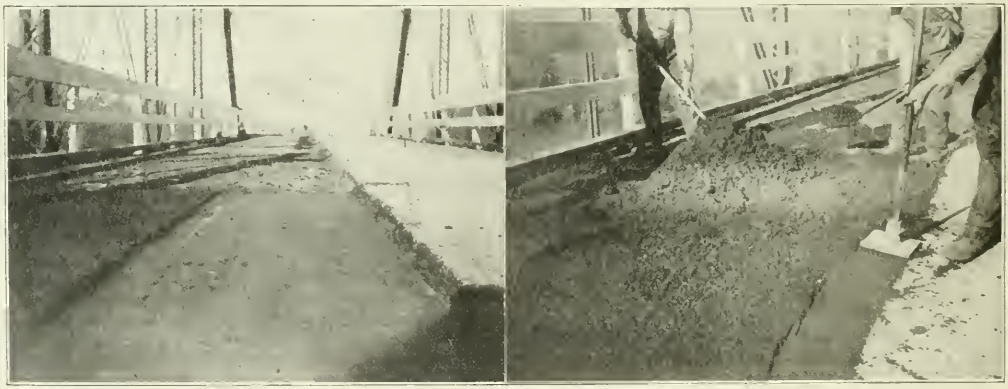
I am unable to account for the deficiency in dust (mesh No. 200) shown in the laboratory tests under that shown by the actual quantity bought and charged into the machine. From investigations the discrepancy seems to be due to the fact that part of the time the limedust was charged directly into the skip with the rock and sand, and passed through the drying drum with the wet materials. As the flame plays directly into this drum, it may be that during the long drying period part of the dust was blown out. There was no evidence of this around the plant in the way of dust deposit, however. It is possible that some change was effected in mixing the dust with the wet material, which balled up the dust and prevented thorough mixing, the lack of uniform mixing showing up in the tests. During the latter part of the work the dust was charged directly into the lower or mixing drum and tests showed better results.



VIEWS OF BACON PORTABLE ASPHALT PLANT USED IN PLACING TOPEKA SURFACING ON WOOD FLOORS OF CALIFORNIA HIGHWAY BRIDGES.

The accompanying pictures show the plant in operation, and also some views of the pavement.

During the cold weather none of the pavement laid cracked, and during the warm days following there was no appreciable softening. The only places where there was any early failure or cracking were on the first bridge laid, where some cracks occurred on account of laying in one course, and on one other bridge, where large loose splinters in the flooring were overlooked in four or five cases, causing the pavement to crack locally. These spots and splinters were removed and no further trouble occurred.



LAYING ASPHALT SURFACING ON WOOD FLOOR OF COSUMNES RIVER HIGHWAY BRIDGE, CALIFORNIA.

Antioch sand (48.9 per cent.), Natomas ⅛ to ½-in. screenings (30.7 per cent.), Standard Oil Company Calol asphaltum, 60 to 80 pen. (9.5 per cent.) and Pacific Portland Cement Company limedust (10.9 per cent.) were the constituents of the mixture.

Average of 49 laboratory tests show the following average percentage in the mixture:

Summary of Work Done

Total length, 5,153 ft. (including approaches).

Surface area, 80,958 sq. ft.

Average thickness, 2⅞ ins.

Specific gravity obtained, 2.16 to 2.24 (depending on the extent of rolling).

Total weight materials used, 1,335.28 tons.

Total cost, $7,553.45, or $0.0934 per sq. ft. 2⅞ ins. thick, $0.8406 per sq. yd., $5.66 per ton asphalt mixture in place.

This cost includes materials, fuel, repairs, labor, superin-

tendence, transportation—in fact, every charge of any nature whatsoever against the work done from start to finish.

The original allowance for asphalt surfacing was $6,800. As there was a saving on the timber construction cost, however, and as there was also an allowance for contingencies, authority was secured to pave several bridges not originally included, so that the final cost of $7,553.45 for asphalt surfacing, against an original estimate of $6,800, represents the increased cost of materials for an average thickness of 2⅞ ins., instead of the 2 ins. of the estimate and the cost of paving the additional bridges.

LAYING ASPHALT SURFACING ON WOOD FLOOR OF COSUMNES RIVER HIGHWAY BRIDGE, CALIFORNIA.

Itemized Cost

Materials of Construction:

		Per ton Mixture in place	Per sq. ft.
Screenings, 409.2 tons	$ 711.95		
Sand, 652.75 tons	422.01		
Lime dust, 145.01 tons	698.20		
Asphalt pavement, 126.82)			
Paint coat 1.50)	1,240.87		
Distillate pt. coat, 850 gals.	68.00		
	$2,744.01	= $2.055	= $0.034

Operating Supplies:

Distillate for engine, 2,02× gals.	$ 161.60		
Fuel oil—plant, 131.14 bbls.	156.17		
Gasoline, 569 gals.	84.03		
Coal, 1½ tons	15.30		
Kerosene, 530 gals.	45.05		
	$ 462.15	= $0.346	= $0.0057

Repairs to Plant:

Chain renewals	$ 31.98		
Sprocket, 14½ in.	3.80		
Sprocket, 6¼ in.	1.70		
Babbetting bear. on compressor	3.08		
Renewing bear. on compressor	3.75		
Grease cups	1.05		
	$ 45.36	= $0.034	= $0.0006

Rentals:

Roller	$ 250.00		
Wagons	123.33		
Superintendent's auto	224.90		
	$ 598.23	= $0.448	= $0.0074

Labor:

Prelimin'y handling of materials	$ 312.74		
Paint coat	206.12		
Mixing (inc. setting plant)	1,041.76		
Hauling	547.81		
Laying	1,061.52		
Superintendent	340.00		
Timekeeper	194.75		
	$3,703.70	= $2.777	= $0.0457
Totals	$7,553.45	$5.66	$0.0934

Equipment for Asphalt Plant

Asphalt plant	$2,368.20
400 gal. heating kettle	299.75
7 beam charging scales	106.25
Dial scales	10.20
Rotary pump	15.45
Two thermometers	6.01
Asphalt bucket	15.35
Piping for asphalt	25.56
Mounting asphalt pump	3.78
Steel plates on sides of drum	16.64
Extensions to fire box	12.00
Belt for pump	3.52
Two oil cans	5.05
Oil burners	32.25
Sprocket and chains	37.48
	$2,957.79

Additional Tools and Equipment Purchased

Tool heater	$ 50.00
65 gal. kettle for heating	108.76
Asphalt for paint coat	.....
Hot hand roller and 35 lb. iron	40.50
16 shovels, 6 smelter brooms, 4 wheelbarrows, 3 wrenches, etc.	56.19
Three mattocks	3.38
Four tampers	8.55
65 lb. smoothing iron	6.00
Two 1 gal. pouring cans	9.75
Miscellaneous hardware	18.94
	$ 302.07
Total cost of asphalt outfit	$3,259.86

This cost of outfit is exclusive of rollers and wagons owned or rented by the state.

The Plant and Its Operation

Now as regards the plant and method of working: The mixer was made by the E. R. Bacon Company on order of the state, based on blueprints showing proposed design. The basis was the "rapid heated mixer," a single drum mixer with flame shooting directly into the drum and another flame into a fire-box beneath the drum. With the single drum mixer the operator was depended upon to turn off the direct fire when charging the asphalt in order to prevent burning. This precaution was frequently overlooked, with the result that a number of failures had been turned out by the small portable mixers.

In order to remove any possibility of burning the asphalt, also with the idea in view of installing a loading skip which the standard "Rapid" mixer did not have, and of securing a greater output than could be secured with a single drum, the plant as purchased by the state was designed.

A wooden platform was built around the skip as a charging platform. A Fairbanks-Morse 7-beam charging scale was placed at the end of this platform and the material wheeled from the stock piles across the scale onto the charging platform.

The first method used was to dump one sack of limedust directly into the skip, a fractional bag of dust sufficient to make up the amount required per batch being dumped onto and weighed on one of the wheelbarrows. It was found necessary, however, to modify this method, on account of the fact that dumping the limedust into the top drum at the beginning apparently (according to test, but not to the eye) allowed a large percentage to be blown out of the drum during the time required to bring the batch up to proper temperature. The later method is necessary during the period of the year when a long time is required to dry out the screenings and sand. In the summer time, when it will require but two or three

minutes to heat a batch, the limedust can be introduced from the start.

Both flames are used in the upper drum to dry the material, but only one flame is used in the lower drum, that in the firebox, so that there is no danger of burning the asphalt by direct contact. When the aggregate is heated to proper temperature in the upper drum, it is turned into the lower drum, the asphalt and limedust being introduced simultaneously and the whole mixed until the next batch is about ready in the upper drum, at which time the mixture is dumped.

A dial scale is hung on an A-frame directly over the charging end of the lower drum. On this scale is hung the asphalt bucket, which holds 100 lbs. of asphalt. In the bottom of the bucket is a pipe outlet with a quick-opening gate valve. A small rotary pump is mounted inside of the asphalt heating kettle and operated by a belt from the shaft which operates the air compressor. The asphalt is pumped through a 2-in. pipe to a point just above the charging bucket and back through a by-pass into the kettle. Both pipes are shown in the accompanying pictures. When time to charge, a gate valve on a pipe charging into the bucket is opened and a gate valve on the by-pass closed. The discharge is accomplished by elevating the frame a little and backing a wagon up to the discharging spout. This looks a little awkward until tried. It has, however, been found very practicable.

All main parts of the plant are standard. The drums are standard "rapid-heated" drums; the hoist for the skip is from the Foote mixer; the compressor is a standard Rix compressor and the engine a 20-h.p. engine.

An Argument for Changing Common Method of Financing Pavement Construction and Renewals

By Charles A. Mullen, Director of Paving Department, Milton Hersey Co. Ltd., Consulting Engineers, Inspectors, Industrial Chemists, Montreal, Canada

A recent article by George C. Warren of Boston, Mass., again opens the controversial subject of: How shall we pay for our pavements? One possibility, not dealt with by Mr. Warren, is, charging them to the public through a wheel tax levied by the city, county or state. The writer would like to see this idea fully exploited; or, to learn where it is in vogue and how it is working, if at all.

Why do we build roads—and pave them? For wheels. No other reason. Were it not for vehicular traffic, other than bicycles and baby carriages, sidewalks and footpaths alone would serve our purpose. And, since we build the pavements for the wheels, wouldn't it be logical to pay for them through the wheels?

It has always seemed to the writer that a tax should be collected through a logical channel. At present, we are fooling ourselves very badly as to the cost of highway transportation. A railway must maintain its roadbed, and collect the cost thereof in its freight charges and passenger fares; while an autobus line, delivery wagon or auto truck, or even a passenger automobile, does not pay for its roadbed, and the expense thereof is not figured into its cost of operation.

A Step in the Right Direction

It is true that some states are taxing automobiles and using the proceeds for road maintenance. This is a step in the right direction; but, why not carry the principle to its logical conclusion, by securing all the money for road building and maintenance through a wheel or vehicle tax? If roads are for vehicles and vehicles alone, why should the general city tax, or the abutting property, pay for them, instead of the owners of the vehicles to whom the wheel tax would be charged? They, in turn, would charge it into the cost of their services to the community, so that, finally, it would rest, as always, upon the ultimate consumer—but, through the logical and proper channel instead of in the present unsatisfactory way.

Montreal as a Bad Example

Illogical procedure may usually be depended upon to produce illogical results. In the city of Montreal, where the writer now spends most of his time, and which pays for both its pavement construction and pavement maintenance out of the general city fund, the illogical results have fully materialized. On the whole, we probably have the worst paved streets in North America.

Because of a stringency in municipal finance, charged by some to war conditions, but due much more directly to purely local causes, quite painful for a citizen of Montreal to mention, the "City Fathers" thought it wise to neglect the street pavements. Thereby they avoided spending some money from the general city fund for those particular years when these particular "City Fathers" were appealing to the citizens for their suffrage, and they were happy.

Money was saved to the particular general city fund; but, in doing so, they wasted a lot of money for the community. After a few years of this kind of "saving," the streets of Montreal are so bad that they can be traversed neither with pleasure nor in safety. Trucking firms were, even last year, threatening to sue the city for damages, because of the excess wear and tear on equipment, and the greater expense of smaller loads made necessary through the ill repair of the pavements.

Now what the general city fund "saved" in dollars and cents was paid out, many times over, in equally good dollars and cents, by the vehicle owners using the streets of the city. They paid in repairs to wagons and automobiles, and in excess horse power—both in the nature of gasoline and oil, and of the old animal flesh-and-blood kind—required to move a given tonnage between given points. They paid heavily; and they kicked to the "City Fathers," to no purpose.

Were the City of Montreal paying for its pavement construction and maintenance by a wheel or vehicle tax, this condition would not exist very long. The vehicle owners would not be slow to realize that they could get the same results at less cost by paying their money into a proper tax fund to build and maintain pavements, rather than by paying it to the wagonsmiths, the garages, the horse dealers, and in excess labor costs to men who are swearing at the discomfort to themselves growing out of the unkept street surfaces.

Answers to Objections to Wheel Tax

Some may object to the wheel tax, as a means of paying for road service, on the ground that it too closely resembles the old toll roads system. To such, it can be said that there were two great objections to the collection of tolls: first, too much of the amount of the tax was spent in the collecting thereof, and second, the toll roads were privately instead of publicly owned. Of these objections, to the writer, the last only seems fundamental; the first is a matter of practical application that is overcome by the wheel tax.

Another objection that might be raised, is, that we are getting away from free public roads. But nothing is free; we are paying for them now, only by a different and less satisfactory method. Nothing that is the result of labor can ever be free. Natural resources may be, but not manufactured products, such as roads. Someone must always pay; so, why not have the burden fall equitably upon the road users through a wheel or vehicle tax?

The writer is not ignoring the fact that so radical a change in the method of paying for our pavements would meet with a lot of opposition from the statu quo. Neither does he claim to have suggested anything new; for the plan was, he is quite sure, advanced by others long ago. What he does suggest is that we really begin to think about doing something along these lines. It is a long way to Tipperary, but it is probably

an even longer journey to a satisfactory method of taxation to pay for road building and paving. Let's hear what the single taxers, and others, have to say about it.

Methods and Cost of Building Gravel Roads in Kane County, Illinois

By Geo. N. Lamb, Superintendent of Highways, Kane County, Geneva, Ill.

In Kane County, Illinois, County aid work consists of the construction of the township roads by the use of the county's outfits of machinery. Three such outfits of machinery are now maintained. Outfit No. 1, here illustrated, is a portable plant for screening and crushing gravel, with motor trucks for the hauling, spreading and rolling.

Outfits No. 2 and 3 are employed in the construction of earth roads, or in the preparation of road beds for the application of gravel or crushed stone. Each of the grading outfits consists of 40 H. P. gasoline tractor, heavy grader, scarifier and drags.

VIEWS OF MODERN ROAD BUILDING MACHINERY OWNED BY KANE COUNTY, ILL., AS OPERATED ON GRAVEL ROAD CONSTRUCTION.

Left: Road Building Outfit No. 1 on the Move. Right: Road Building Trucks.

Rebuilding Old Gravel Roads

Many of our old gravel roadbeds formerly built for team traffic only, are so narrow or crooked and so poorly built that they have to be entirely torn up and re-shaped before fresh gravel is applied. To do this work properly often necessitates the destroying or covering up of all the gravel or other surface applied in former years. It is often a serious question whether to sacrifice all previous expenditures and rebuild the road or to practice false economy by tolerating the defects and resurfacing the road as it stands. To practice the former method means a greater present cost, but an end to future wasteful expenditures; the latter means a lower present cost with a continuance of make-shift repairs, until some future time when reconstruction will have to be accomplished. Heretofore in the construction of roads, too little attention has been paid to the proper shaping, alignment, grade reduction and drainage and very few of the old roads throughout the county are in condition to warrant the application of a permanent surface until they have been entirely rebuilt.

Use of Modern Road Building Machinery

Before any gravel or other surfacing material is applied the roadbed itself should be permanently improved. With this end in view Kane County is now equipped with modern road building machinery suitable for this class of work. Considerable work has been done by means of this road building machinery which otherwise could not have been accomplished. Gravel crushed and screened to the proper size has been placed on roads at a moderate cost at distances from the pit, which under other conditions would have made the cost even of an inferior material nearly if not quite prohibitive.

Early in the spring of 1917 we foresaw that the amount of work planned for Outfit No. 1 was much greater than could be accomplished in one season of ordinary work. Accordingly electric lights were installed, to permit the operation of the plant at night. Two complete crews were employed and the machinery was operated 18 hours per day, the men changing shifts at noon. While this plan has practically doubled the working capacity of the machinery, as well as the amount of gravel crushed and hauled, we still were not able to do all the work requested by the various townships.

The work done by this outfit for the year ending December 1, 1917, comprised: 9,817 cu. yds. of gravel crushed, hauled, spread and rolled; the average length of haul (1 way) was 2.9 miles; the extreme length of haul (1 way) ranged from 3 to 6.3 miles for the 7 townships; the total work done in ton-miles was 42,356.

Cost Data

The cost of producing and delivering road material by this outfit varies considerably, depending on the road and weather conditions as well as on the accessibility of the gravel pit. If the gravel pit is situated near the roadside, a hard rain will delay us only a few hours at the most; but if the pit is located far from the road, the mud in the field is apt to cause a delay of several days.

We give below the cost data in one township (Blackberry Township) where the work was done under average summer weather conditions. In this township the average length of haul was 1.9 miles (1 way) and the extreme length of haul (1 way) was 4.2 miles.

Road No. 11—Spreading, 4.0 cts. per cu. yd.; hauling, 54.8 cts. per cu. yd.; hauling, 18.3 cts. per yd.-mile; crushing and loading, 53.4 cts. per cu. yd.; per yard delivered on road, $1.12. 315 cu. yds. of gravel; Sept. 17-20, 1917; length improved, 0.8 miles; grading road No. 11, outfit No. 3, $113.74.

Road No. 15—Spreading, 2.1 cts. per cu. yd.; hauling, 27.0 cts. per cu. yd.; hauling, 27.6 cts. per yd.-mile; crushing and loading, 41.0 cts. per cu. yd.; per yard dellvered on road, 78.0 cts. 336 cu. yds. of gravel; August 10, 16, 20-23, 1917; length improved, 0.7 miles; grading road No. 15, outfit No. 3, $53.11.

Road No. 20—Spreading, 3.9 cts. per cu. yd.; hauling, 50.9 cts. per cu. yd.; hauling, 20.6 cts. per yd.-mile; crushing and

loading, 50.7 cts. per cu. yd.; per yard delivered on road, $1.05. 205 cu. yds. of gravel; August 24-27 inclusive, 1917; length improved, 0.5 miles; grading road No. 20, outfit No. 3, $30.94.

Road No. 21—Spreading, 2.8 cts. per cu. yd.; hauling, 25.4 cts. per cu. yd.; hauling, 25.7 cts. per yd.-mile; crushing and loading, 29.7 cts. per cu. yd.; per yard delivered on road, 57.9 cts. 163 cu. yds. of gravel; August 13 and 14, 1917; length improved, 0.3 miles; grading road No. 21, outfit No. 3, $30.04.

Road No. 22—Spreading, 2.7 cts. per cu. yd.; hauling, 36.6 cts. per cu. yd.; hauling, 20.9 cts. per yd.-mile; crushing and loading, 42.0 cts. per cu. yd.; miscellaneous, 1.4 cts. per cu. yd.; per yard delivered on road, 82.7 cts. 1,169 cu. yds. of gravel; August 16-24, 27, 29, 30 and 31, Sept. 1 and 12, 1917; length improved, 2.4 miles; grading road No. 22, outfit No. 3, $136.57 (1.6 mi. only).

Road No. 23—Spreading, 2.0 cts. per cu. yd.; hauling, 26.9 cts. per cu. yd.; hauling, 45.0 cts. per yd.-mile; crushing and loading, 36.6 cts. per cu. yd.; per yard delivered on road, 65.5 cts. 150 cu. yds. of gravel; Aug. 15, 1917; length improved, 0.4 miles; grading road No. 23, outfit No. 3, $69.20.

Road No. 24—Spreading, 2.5 cts. per cu. yd.; hauling, 62.8 cts. per cu. yd.; hauling, 19.4 cts. per yd.-mile; crushing and loading, 24.5 cts. per cu. yd.; miscellaneous, 24.5 cts. per cu. yd.; per yard delivered on road, $1.38. 300 cu. yds. of gravel; Aug. 4-7, Sept. 10 and 11, 1917; length improved, 0.2 miles; grading road No. 24, outfit No. 3, $47.99.

Use of Road Tar Growing

The war has changed a plan of building roads. The roads connecting cities have been subjected to a test which had never been applied previous to the commencement of hostilities. Thousands of heavy trucks, each with its capacity load, have traveled over our highways between business centers. Trains of army trucks have hauled men and supplies between mobilization camps throughout the country. Due to the tie-up in railroad transportation facilities and various embargoes in some sections of the country, commercial trucks have been placed in use to make regular runs between different cities. As an example, 640 trucks make 7,200 trips between Philadelphia and New York each week, all over the same highway.

This increased volume of heavy vehicles traveling over the country roads has in many cases shown the inadequacy of the macadam type of road for very heavy loads. The macadam road is excellent for travel purposes if kept in repair. Due to the shortage of labor, country and state highway departments have been unable to cope with the situation, and as a result ruts formed in the surface of the macadam road, and not being in many cases repaired, have grown worse and the roads are almost beyond repair.

The sections of road having a road tar base—that is, a stone road cemented with a prepared tar binder and stone dust—have in every case proved superior to the macadam type. This class of road has the advantage of being able to withstand heavy traffic without forming ruts. There is no loose dust to be drawn up from the road surface by the suction of the tires, as happens in a macadam road. The main traveled highways of the nation that are paved with this tar cemented stone are bearing the burden of increased traffic without weakening, and it is safe to say that in the future probably all roads that have a large amount of travel will be paved with the bitulithic preparation instead of macadam.

SEWER DESIGN AND CONSTRUCTION

Organization of Forces and Plant and Methods Employed in Construction of Sewers in Chicago

By Herbert E. Hudson, Division Engineer, Board of Local Improvements, City Hall, Chicago

The development and extension of the sewerage system in a great city like Chicago, has brought about many interesting features along the lines of efficiency in construction work and field organization.

Standardization of Organizations

In a field like that offered by Chicago, where 60 to 80 miles of sewer are constructed each year, there is a great opportunity for standardization of organizations, particularly among those contractors who handle the same general classes of work year after year.

Records of cost prices covering a period from 1907 up to the beginning of the war, show that there was a steady decrease in the cost of sewer construction in Chicago. The cost of labor and material during that time was on the steady increase, and the analysis of the cost figures shows that the lower cost can be attributed only to two factors. The first and foremost factor is undoubtedly the advent of excavating machinery into this field of construction. Coupled with the use of machinery there came the second factor—careful study and perfection of organizations.

Influence of Excavating Machinery on Labor

The use of excavating machinery, which permits a more rapid rate of construction, has required that contractors select workmen who are particularly adapted to certain kinds of work and who have proved their skill in performing individual operations. The skillful manner in which some of these workmen perform their work is almost beyond belief. For instance, certain workmen engaged in trimming the bottom of the excavation on which the pipe is graded will perform this duty hour after hour with variations that do not exceed ¼ in. to ½ in. The city inspectors are required to guage each pipe to a line, and the taking up and relaying of any one pipe occasions a loss of time. It therefore behooves the workman who is striving to keep up with the excavating machine to exercise great care in his work. Certain classes of workmen in Chicago pride themselves on their skill in this work and are retained by the contractors year after year.

The economy of machine work depends very largely upon the continuous operation of the machines, and thus it becomes necessary for the contractor to develop his organization in such a way that the rate of construction can be balanced with the rate of excavation. The constant danger of interruption to this plan has been the likelihood or danger of breakdown in machinery, and while this difficulty was very serious during the earlier experimental stages of machine work it has been greatly reduced in later years.

Classes of Construction

In Chicago, there has been a natural division of sewer work into classes. The first class of construction, we may say, is the sewer work constructed in machine excavation. This class further subdivides itself into the small and large sewers.

The design of excavating machinery and the development of its use in field construction has drawn a natural line of

division between the large and small sewers somewhere between 3 ft. and 4 ft. in diameter. Sewers ranging in size from 3 ft. down are classed as small sewers, and those ranging from 4 ft. up are classed as large sewers.

Small Sewers

Machines which handle the small sizes of sewers are usually developed for speed of travel for the narrower trenches, and their efficiency has been worked out on this class of work. Actual yardage of excavated material is large, but it is excavated in small units and at a great speed. These machines are often equipped with changeable speeds and various sized buckets or other arrangement for trench width such as will enable them to dig trenches for sewers larger than those indicated in the general classification as small. For instance, there are three types of machines of the endless belt type capable of excavating for small pipe sewers at great speed that can be geared down and made to dig trenches for sewers up to 5 ft. in diameter. The contractors in general, however, seem to draw the dividing line about where it has been indicated, and show considerable hesitation in overstepping the limits indicated. Other contractors have tried the use of larger machines capable of excavating for the larger size sewers equipped with special fittings for digging small pipe sewers. The loss in efficiency has been much more apparent in these cases. While it may be possible to equip the machines used on small work so that they may operate with a fair degree of economy on some of the larger sizes, the reverse condition is not so true, and usually little economy has been accomplished in the use of heavy machinery for lighter work.

Hand Excavation and Miscellaneous Class

In addition to the work constructed in machine excavation there are two other classes of work, namely, those constructed in hand excavation and a miscellaneous class.

Hand excavation on certain classes of work may be due to special conditions, such as rock, running sand, etc. The third class, called "miscellaneous," includes such work as digging up and rebuilding existing sewers, or the construction of new relief sewers in closely built-up communities. This last class usually requires special machinery for excavation, or possibly hand excavation under particularly difficult conditions.

Development of Excavating Machinery.

Going back to the classifications of work done in machine excavation, we find that the greatest progress has been made in the development of machinery for this kind of work on the so-called smaller sizes. During the last ten years approximately six different types of machines with which the writer has been familiar have been developed and tried out in the Chicago field. Two of these machines have survived as being the most efficient and satisfactory for this work. Each of these machines has gone through a process of evolution so that one

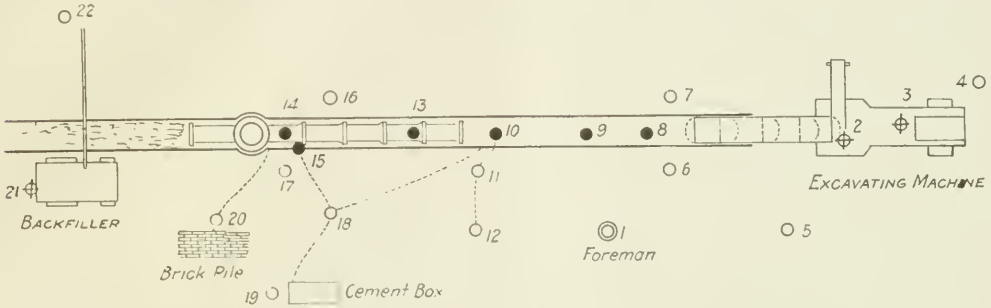


FIG. 1—CHICAGO ORGANIZATION FOR CONSTRUCTING SMALL SEWERS WITH POWER EXCAVATORS AND BACKFILLERS.

1, Foreman. EXCAVATING ORGANIZATION: 2, Operator; 3, Fireman; 4, Laborer; 5, Coal Passer; 6 and 7, Bracing Tenders; 8, Bottom Bracer; 9, Bottom Man. CONSTRUCTING ORGANIZATION: 10, Grader; 11, Lowering Pipe; 12, Pipe Passer; 13 and 14, Brick Layers; 15, Brick Layer's Tender; 16, Laborer; 17, Brick Tosser; 18, Cement Carrier; 19, Cement Mixer; 20, Brick Wheeler. BACKFILLING ORGANIZATION: 21, Backfiller Operator; 22, Laborer.

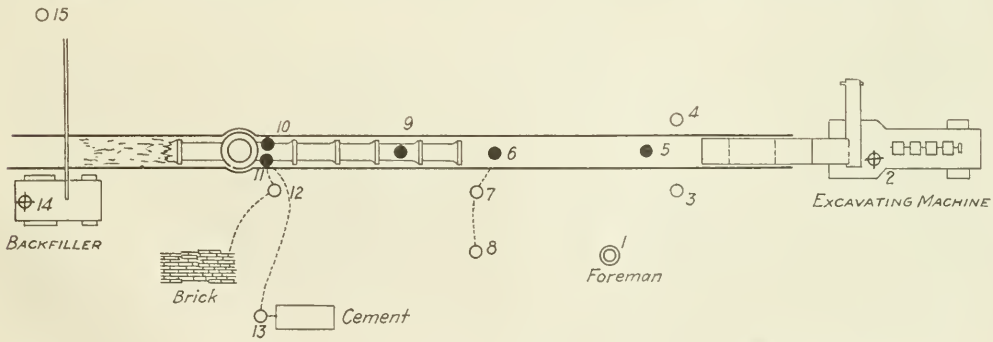


FIG. 2—CHICAGO ORGANIZATION FOR CONSTRUCTING SHORT LENGTHS OF SMALL SEWERS WITH GASOLINE DITCHER AND BACKFILLER.

1, Foreman. EXCAVATING ORGANIZATION: 2, Operator; 3 and 4, Bracing Tender; 5, Bracer and Bottom Man; CONSTRUCTING ORGANIZATION: 6, Grader; 7, Lowering Pipe; 8, Pipe Passer; 9 and 10, Brick Layers; 11, Brick Layer's Tender; 12, Brick Tosser and Carrier; 13, Cement Mixer and Carrier. BACKFILLING ORGANIZATION: 14, Backfiller Operator; 15, Laborer.

would scarcely recognize the present type of machine as a development from its original form. Some parts have been made stronger, some of the methods of handling excavated material have been changed, and the tendency on the whole has been toward a more rapid excavation. This tendency toward speed in excavation has necessitated the contractors' increasing the efficiency of the organization which is to follow behind the excavating machine.

Organization of Forces

The organization of the field force surrounding one of these machines may be divided into three separate groups: the excavating organization, the constructing organization, and the backfilling organization.

The constructing organization may be further subdivided into that which constructs the sewer proper and that which constructs the various structures connected with the sewer, such as manholes and catchbasins. The organization given below is a type organization such as might be found following a machine excavation for a small sewer.

Excavating Organization

In the excavating organization, if the machine is operated by steam, we find an operator and fireman on the machine. There is another man carrying coal and levelling the ground ahead of the machine. Immediately behind the machine there consists of one bricklayer, one bricklayer's tender, one brick tosser, one brick carrier, one cement carrier, and perhaps an odd laborer. In this group then there are six men.

As an added number to these two constructing groups there will be the cement mixer and another odd laborer, all under the supervision of a competent foreman.

Scheme for Relieving Tired Men

When ground conditions are favorable and the average excavation does not exceed 8 ft. or 9 ft. deep, these excavating machines are capable of digging from 1200 to 1600 ft. of trench in a working day of 8 hours.

The handling of the material for the construction of this kind of sewer becomes a very great problem, and it is frequently necessary to make changes in the men so that the burden of the hard and fast labor will not fall too long upon the shoulders of any one or two men. When the contractor has reason to expect that he is going to make this rapid progress, or when the size of the sewer becomes 20 in. in diameter or greater, he usually supplies from 3 to 6 additional laborers who are kept busy at odd work around the machine and are kept as alternatives for replacing the men in the regular organization when they become tired.

Backfilling Organization

The backfilling on such a job is usually done by a type of

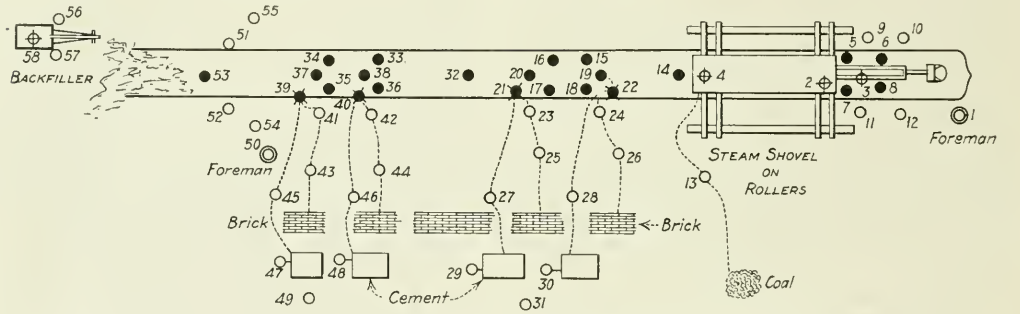


FIG. 3—CHICAGO ORGANIZATION FOR CONSTRUCTING LARGE SEWERS WITH USE OF HEAVY MACHINERY.

1, Foreman. ON MACHINE: 2, Engineer; 3, Craneman; 4, Fireman. EXCAVATING ORGANIZATION: 5, 6, 7 and 8, Bottom Trimmers and Bracers; 9, 10, 11 and 12, Sheeting Passer and Roller Tender; 13, Coal Passer; 14, Bottom Trimmer; BOTTOM OR INVERT ORGANIZATION: 15, 16, 17 and 18, Brick Layers; 19 and 20, Brick Layers' Tenders; 21 and 22, Scaffold Men; 23 and 24, Brick Tossers; 25 and 26, Brick Wheelers; 27 and 28, Cement Carriers; 29 and 30, Cement Mixers; 31, Laborer; 32, Form or "Center" Setter. ARCH ORGANIZATION: 33, 34, 35 and 36, Brick Layers; 37 and 38, Brick Layers' Tenders; 39 and 40, Scaffold Men; 41 and 42, Brick Tossers; 43 and 44, Brick Wheelers; 45 and 46, Cement Carriers; 47 and 48, Cement Mixers; 49, Laborer; 50, Foreman in Charge Constructing Organization; 51, 52 and 53, Laborers Pulling Sheeting; 54 and 55, Laborers Carrying Sheeting. BACKFILLING ORGANIZATION: 56 and 57, Laborers; 58, Operator on Backfilling Machine.

are two men engaged in handing down sheeting and steadying it until one of the bottom men has placed the cross bars between the upright sheeting. Following the excavating machine in the bottom of the trench there are usually two men; one man engaged in throwing the loose excavated material ahead to the buckets as they pass around and placing sheeting and braces, and the other man engaged in trimming up and smoothing the bottom of the trench so that the pipe laying may follow rapidly. This gives a total of seven men in this group.

Constructing Organization

Following this group comes the constructing organization laying the sewer proper. Here we have one man in the bottom laying the pipe, and under Chicago conditions we have a bricklayer sealing off the pipe and junctions as rapidly as they are laid. On the surface of the ground there is one man passing pipe down to the pipelayer and one man engaged in carrying pipe from the side of the street to the trench. In this portion of the constructing crew there are four men.

In addition to this construction group there is a force engaged in building manholes and catchbasins. This force usually

backfilling machine, several of which have been developed to meet the demand created by the perfecting of the excavating machinery. One of the most popular among the gasoline driven machines is shown herewith. It is the Parson's trench filler. This machine requires one man to operate the machine and one man to guide and steady the bucket or bucket board. Several attempts have been made to do away with the man guiding the bucket or bucket board, but up to the present time no type of machine has been developed which completely eliminates this man. This is particularly true of the lighter machines used for this work. There have been one or two heavier machines developed carrying a heavier bucket board, which apparently needed only occasional steadying by hand, but these machines have been so much heavier and more cumbersome that the rate of progress they have shown has not compared favorably with the lighter machines requiring the additional man. These machines have not been capable of backfilling each day all of the trench excavated by the excavating machine, but, as there are usually delays of one kind or another arising on this kind of work, the machines are on the whole

able to maintain an average rate of backfilling about equivalent to the average rate of excavation.

Including the night watchman, the total organization for such work will usually number 22 to 28 men. The actual number employed may be as low as 22 when skilled and well-trained men are employed. There are usually some new men in the group and this will necessitate additional men up to the number indicated. See Figure 1.

The constructing organization is about the same as that indicated in the former organization, except that there is an opportunity to do away with the man carrying pipe from the side of the street. If the material is properly distributed along the line of the work, there is also an opportunity to do away with the man who carries brick. Such an organization is indicated in Figure 2, and carries a total of 14 workmen under the direction of one foreman.

EXCAVATING FOR LARGE SEWERS IN CHICAGO WITH 70-TON MARION STEAM SHOVEL.
Note Method of Supporting Shovel Over Trench on Truss and Rollers. Lower View Shows Trench in Sand Under Shovel.

Standard Reduced Form of Organization

The general organization indicated for the smaller sewers is that which would be used by a contractor equipped with a machine capable of performing the amount of work indicated for the 8-hour day. There are several contractors in Chicago equipped with excavating machines for this class of work, whose machines are not capable of the rate of excavation indicated in the foregoing organization. In order to balance their efficiency and costs so that they may compete with the others, it becomes necessary for them to eliminate some of the workmen.

A gasoline driven machine eliminates the firemen. It also eliminates the necessity of carrying coal or maintaining a water line. The extra duties of this coal passer are usually performed by the man handling sheeting or by the odd laborers. As the speed is not so great, there is only one man in the bottom behind the machine who does all the bracing and trimming. The organization used for digging is therefore reduced to four men instead of seven.

Such an organization is used for the construction of small lengths of work, and it is very often possible for the contractor to do away with one bricklayer in such an organization, allowing the pipe to be laid and sealed by the bricklayer, and then during the occasional delays having the bricklayer go back and construct necessary manholes, allowing the catchbasins to be left until the sewer proper has been constructed. He can then so arrange his organization that a portion of the workmen are excavating for catchbasins while the bricklayer is building them.

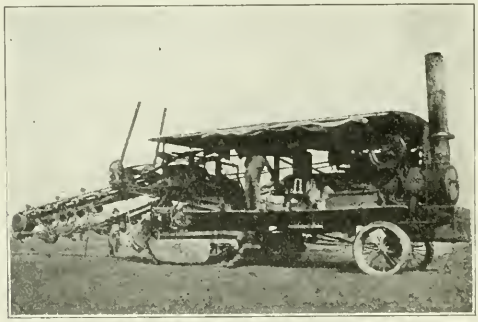
TYPES OF SEWER EXCAVATING AND BACKFILLING MACHINERY SUCCESSFULLY EMPLOYED BY CHICAGO CONTRACTORS.
Left: Parsons Model 78 Trench Excavator. Right: Parsons No. 10 Backfiller Equipped with 30 Ft. Swinging Telescopic Steel Boom, Parco Traction and Automatic Scraper.

The outfit for backfilling is the same as that indicated for the other organization.

It must be understood that these organizations are set up as types of standard organization such as might be used for certain classes of work, and that various contractors interchange or rearrange the labor to suit special conditions on their work. Variations in soil character, depth of excavation, size of sewers and many other conditions will enter to change this standard organization.

Keeping Close to the Machine

It is an unwritten rule on this class of work that the laying of the sewer and the construction of manholes on the sewer should follow as closely behind the excavating machine as possible. The efficiency of this method is apparent. It is not then necessary to sheet or brace the walls of the trench as thoroughly as where other procedure is followed. The machine automatically sets the pace for the workmen to follow and this has a tendency to increase the speed of the workmen. The



VIEW OF AUSTIN TRENCHING MACHINE SUCCESSFULLY EMPLOYED ON SEWER CONSTRUCTION IN CHICAGO.

contractor is also enabled to keep his organization together and under his eye. One of the greatest economies which the contractor can accomplish is found in the utilizing of the odd laborers or spare workmen on such work. When these men are not actually performing some duty in connection with the excavation for or construction of the sewer, they can be used in backfilling over the pipe, digging out braces and sheeting and carrying them ahead, moving cement boxes, and the multitude of small duties that are found in attending such construction work.

Chicago, who have followed this construction for a number of years, is as carefully planned and timed as one could imagine.

Use of Steam Shovels

In regard to the larger sewers constructed in machine excavation there has been little change in the general type of machine used for this work. About 1893 a Chicago contractor conceived the idea of mounting a steam shovel on stringers across the trench and excavating for the larger sizes of sewers with this machine. This practice has been developed somewhat, and the efficiency of the organization constructing the work in this kind of excavation has been greatly improved, and, while the general arrangement is the same, the cost figures and the rate of progress show that the Chicago contractors regard it as an efficient and economical method of constructing sewers.

Manufacturers of steam shovels have constructed special booms and dipper sticks for deeper excavations and have equipped these steam shovels with larger drums and more powerful engines, showing that they have recognized this field of work.

Organization for Construction of Large Sewers

The organization of the force for the construction of a large sewer varies greatly with the size of the sewer and the depth and character of the excavation. In a manner similar to that outlined in the small sewer work, this organization may be divided into three groups: the excavating, the constructing, and the backfilling organizations.

Type of Organization on Large Sewers

As a type of organization, let us take the force used to construct a 5-ft. circular brick sewer in an average cut of 15 ft. See Figure 3. The excavating force on such a job consists of the engineer, fireman and craneman on the steam shovel; one man is also engaged in carrying coal to the shovel. Working immediately around the shovel there are two men engaged in carrying planks and rollers ahead to provide the run-way for the machine. In addition, there are two men engaged in carrying up sheeting and bracing from the rear of the trench and placing it so that it may be easily reached when it is

VIEWS ON CONSTRUCTION OF LARGE SEWERS IN CHICAGO.

Left: Laying the Brick Invert. Right: Clamshell Bucket Operated by Locomotive Crane; Contractors' Favorite Equipment for Backfilling Large Sewers.

Keeping Expensive Men Busy

The balancing of the work so that the higher priced men, such as bricklayers, machine men, etc., are not allowed to stand idle is one of the great problems of this class of work. The preparation of the excavation for the construction of manholes and catchbasins for the bricklayers and the steady repair or moving of the machine will tax the contractor's ingenuity to the utmost. Most of the work done by the contractors in

necessary to sheet a new section of the trench. Working directly below the shovel in the bottom of the cut there are four men; two of these men are usually engaged in trimming and shaping the bottom preparatory to laying the brick work, and the other two are usually engaged in running forward between each cut of the dipper and trimming the banks so that the sheeting will assume a straight line.

When the signal is given to the engineer that the excava-

tion has proceeded to a proper point the four men in the bottom carry forward a temporary scaffold and quickly place it across the trench. This usually consists of two or three pieces of 2-in. pipe cut so that they just span the width of trench. Upon these are placed 2-in. planks so that when the men stand upon these planks they can reach the level of the stringers supporting the sheeting. The four men on top then pass down the stringers and sheeting for the new section of trench to these men on the scaffold.

After the stringer has been placed and the sheeting dropped in behind, the men on the top usually cut down a little fine material so that when the brace is tightened there is a firm and even bed between the sheeting and the wall of the trench. The signal is then given for the move ahead, and the four men on the surface "stand by" to watch the rollers as the machine is pulled ahead. While this is being done the four men in the bottom are usually engaged in putting in permanent braces and stringers for the section which has just been "sheeted."

The progress of the steam shovel, aside from the ability of its operator, is almost entirely dependent upon the rapidity with which this organization carries out its work.

Rates of Progress

There have been several instances under the observation of the writer where the sheeting and bracing of a section of trench and the move ahead have been completed in from 4 to 9 minutes on the type of work indicated. The writer has also been familiar with several organizations where this same work took from 15 to 25 minutes.

In addition to the two men indicated as trimming the bottom of the trench, most contractors have found that it was to their advantage to have an additional man in the bottom setting the form for the brick work and finally shaping the trench. Nearly all contractors have found that it also pays to have a foreman whose duties are entirely concerned with the operation of this excavating crew. It is his duty to see that the steam shovel is properly lined up, that the sheeting and bracing is done properly, and that the efficiency of the whole organization is at its top notch.

Such an organization will dig from 160 to 200 ft. of trench in good clay soil in a working day of 8 hours.

If the construction organization is such as will keep pace with this organization, these rates can be maintained. Usually, however, it is found that the rates of speed on the average are not such as to justify an organization capable of constructing 200 ft. of this class of work.

The writer is familiar with a number of pieces of construction of this class, where the constructing organization was limited to 160 ft. to 180 ft. per day, and the excavating organization were allowed to go home after completing a sufficient amount of trench. These men realizing that they were working for their own personal gain, therefore developed a great efficiency and were known to go home at 2 and 3 o'clock in the afternoon after completing a sufficient amount of work for that day.

Constructing Organization on Large Sewers

The construction organization which follows behind this excavation is developed into two parts, but quite differently from the division on the small work. It is customary on this work to organize the forces into what are known as "bottom" or "invert" and "arch" crews. The "invert" gang constructs the lower half of the sewer from the flow line to the spring line. It is then necessary for the contractor to set up a temporary center for the support of the "green" brick work and the arch, and on this the "arch" gang constructs the upper half of the sewer.

VIEWS SHOWING PROCEDURE IN SEWER EXCAVATION IN CHICAGO; STEAM SHOVEL MOUNTED ON ROLLERS OVER TRENCH.

Left: At Signal for Shovel to Stop Digging. Center: Cross Pieces in Place, Showing Method of Placing Temporary Supports for Bracers. Right: Standing Boards in Place; Lowering Stringer in Place with Temporary Brace; Sheeting Going In; Filling Behind Sheeting.

Invert and Arch Gangs

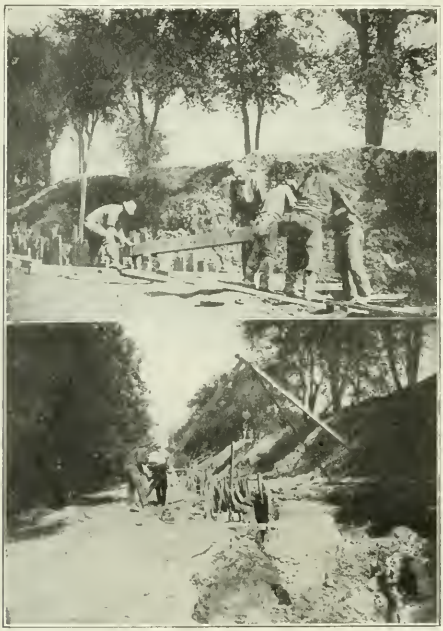
The constructing organization for the "invert" of a sewer of the size indicated would consist of four bricklayers with two bricklayer tenders, two scaffold men, and two brick tossers. Carrying or wheeling brick to these tossers are two brick wheelers, and carrying cement are two cement carriers. It has been found very advantageous on this class of work to set up guard stakes and sheeting along the side of the trench against which the brick can be piled in quantity sufficient for the masonry work so that all of the brick will be within easy reach of the brick tosser and no delay result in his reaching for material. It has also been found that a long plank thrown across the trench will enable the cement carrier to hand his cement directly to the scaffold men and thereby occasion little delay in stopping the brick tossers. These cement carriers watch their opportunity and when the brick tossers and scaffold men stop for a moment, as they usually do on this work, the cement is passed down quickly to the tenders in the bottom and the tossing of brick resumed with almost no delay. It has also been found that two cement mixers are needed for this work; one mixer is usually preparing sand and cement and getting the next batch of cement ready while the other is engaged in tempering and turning over the mortar which is being used. By the time his box is empty the other is ready for use. These men are usually assisted by one laborer. As soon as the invert is completed the joints are "struck" and the organization moves ahead into the next "bottom."

Between the "bottom" gang and the "arch" comes the "center setter." It is his duty to "strike" or take down the centers after the work is set, carry them forward and set them up ready for the new work. This work usually requires a major portion of his time, but when a man becomes skilled at

the work he has considerable time during which he is usually engaged in "cleaning down" the arch or wheeling ahead the surplus cement from the completed work. On these forms the "arch" gang constructs the brick work in two sections. Usually there are four bricklayers in such a crew working in pairs. The two leading bricklayers construct the wall from the spring line up, turning the so-called "quarter," while the two followers close or "key up" the arch.

Maintaining Progress Balance Between Invert and Arch Gangs

The organization for cement and brick is practically identical with that of the "bottom" crew. When it is necessary to construct a manhole on the sewer, one bricklayer is usually detailed for this work. This necessitates a slight rearrangement of the gang and usually slows up the arching process, and it frequently becomes necessary to bring back the bricklayers from the bottom and turn a sufficient amount of arch so that it may be kept fairly close behind the invert construction. Any such rearrangement of crew results in confusion, and the contractors are more apt to put on extra bricklayers in either "bottom" or "arch" gang so that proper balance may be maintained. The difficulty in employing an extra bricklayer comes from the fact that it usually necessitates the employment of an extra tender. These tenders are capable of handling material for two bricklayers, and the contractors are more apt to employ two bricklayers at a time and endeavor to balance the rate of construction by sending them from the bottom back to the arch and vice versa. Such an extra crew understands its duties and performs them with less confusion than that occasioned by the transfer of the whole "bottom" or "arch" gang.



TWO METHODS OF PULLING SHEETING ON CHICAGO SEWER CONSTRUCTION.

Upper: Lever Method; Five Men Required. Lower: By Two-Speed Builders' Hoist; 3 Men Required.

In charge of this constructing organization there is usually a foreman whose sole duty is to see that the materials are kept moving properly and regularly to the workmen, and that the proper balance in rates of construction is maintained between the arch and the invert. Following this constructing crew there are usually three or four men taking out braces and removing sheeting from the trench. Supplementing this work there are two men engaged in carrying this material ahead to the new excavation. Where the shovel is maintaining a fair rate of excavation, the travel of these men from the rear to the shovel may be as much as 200 or 300 ft. As the sheeting and braces are easily taken out, the men engaged in their removal usually have sufficient time to cut down the sides of the bank and backfill around the sides or quarters of the sewer before the centers are struck.

Backfilling With Orange Peel Bucket and Locomotive Crane

Following this organization comes the backfilling. On the class of work indicated several types of backfillers have been developed. The range of experiments for this purpose seem to have covered the whole field. Almost every imaginable type of machine has been tried out—drag line buckets, orange peel buckets, clam shell buckets and many special types of buckets have been tried. In general, the Chicago contractors have conceded that the best type of machine for this class of work is the orange peel bucket carried by a locomotive crane. This machine is self-propelling, has a wide range of operation, and is capable of cleaning up the work in very good shape, and is usually operated by one man. It has been found that two laborers accompanying such a machine are usually sufficient. These men adjust the track or run-way for the machine and maintain the water connections. Such an organization as that indicated is ample for maintaining the rate of speed indicated under the excavating.

Value of Skilled Labor

It must be borne in mind that this organization as outlined is typical for one condition only, and is simply a standard which has been established by practice among the Chicago contractors, and is based upon the rates of pay and efficiency of the Chicago workmen. These men are peculiarly skilled in their work and are familiar with local conditions so that the efficiency maintained is uniform and can be duplicated in any one of several organizations.

The employment of unskilled labor in this class of work has usually been disastrous, and the time and labor spent in training them is usually far more costly than the higher wage paid to the skilled workmen.

Sources of Delay

As in the case of the smaller sewers, the opportunities for economy are many. Delays in machine excavation due to breakdown of machinery or bad or caving ground under the shovel often require the contractor to readjust his organization entirely, and even under the best conditions the contractor must be constantly on the alert. One of the frequent sources of delay is lack of sheeting. If the ground becomes very good the contractor is tempted to speed up the excavating, and soon finds himself with all his sheeting in place and nothing left for the new excavation. Oftentimes the excavated trench will cave under the sheeting and require excavation by hand on scaffold. This introduces great delay.

The Chicago contractors believe that they have developed their constructing and other organizations to a point far ahead of that found in any other similar work. The writer believes that this opinion is largely justified, but believes that it comes about more largely through the attention given to the individual workmen and the training and skill which have been imparted him. The peculiar labor conditions obtaining in Chicago have restricted this field in certain ways, so that the class of men employed has been fairly constant and their skill has increased accordingly. The rates of pay are exceedingly high when compared with common labor, but it is the opinion of the writer that the workmen are more than common laborers and that the results attained by them for their contractors have more than justified the high rates of pay. This is true on both classes of sewers, both small and large.

Facilitating the Construction of Water and Sewerage Works by Means of the Cement-Gun

In recent years, the Cement-Gun has established itself as one of the dependable working tools of the engineering and contracting professions. We present herewith several specific examples of the successful application of the Cement-Gun process in the construction of water and sewerage works in various American cities:

Columbus, Ohio

One of the views shown herewith illustrates the use of a Cement-Gun on the reconstruction of the well known sewage disposal works at Columbus, Ohio. This work was let with the specifications calling for 3 in. walls on the sides of the slope chambers. An unsuccessful attempt was made to pour concrete walls of this thickness. The resulting concrete was of such poor quality that it quickly disintegrated. A Cement-Gun was then brought on the job to correct this difficulty, and the trial was so successful that the practice of pouring thin walls was abandoned and the remaining walls were built up by the gun, as shown in the photograph, the gunite being shot against the reinforcing metal. The result was quite satisfactory.

Albany, New York

At Albany, N. Y., the Cement-Gun was used to cover concrete tanks with a coating of mortar. The operation of the gun at Albany was so rapid as at times to require the employment of 10 to 12 masons to trowel the applied surface.

USING THE CEMENT GUN PROCESS TO CONSTRUCT 3-INCH WALLS IN COLUMBUS, OHIO, SEWAGE SETTLING TANKS.

Views are shown herewith of the sewage disposal plant at Albany, on which this work was done. One of the views shows a general view of the plant under construction, and the other view shows concrete being covered with cement-gun mortar. Note the fact that in this illustration, one cement-gun is keeping five masons busy troweling the surface.

In a letter to the editor, relative to this work, Mr. Stephen B. Vernon, engineer of Intercepting Sewer Design and Construction, of Albany, advised that the inner slope walls of the Imhoff tanks in the Albany sewage treatment plant, were coated with about ¼ in. thickness of the gunite, and this was troweled smooth. This was not done for water proofing purposes, but rather to get an absolutely smooth surface, down which the sludge would easily flow to the sludge chambers. Mr. Vernon states that in the application of the gunite, they seem to have secured good results. As to the choice of methods for doing this kind of work, there is the use of the gun and troweling by hand, and the former was chosen because the cheaper. Undoubtedly the best results could have been obtained by troweling the original concrete soon after its initial set. This was impossible of accomplishment, since the work would have suffered during the after-construction and the smooth surfaces would have required a large amount of repair.

In troweling gunite, masons should be cautioned not to make too free use of their floats and trowels, because of the danger of injuring the permanency of the plastered coat.

St. Louis, Mo.

Some very interesting work has been done by the City of St. Louis, using the cement-gun in making repairs on old sewers. The engineers of the City of St. Louis conducted experiments to determine the availability of the cement-gun for relining old sewers of large diameter. Theoretical considerations indicated that the capacity of rough brick and ashlar sewers could be increased sufficiently by the addition of a smooth mortar lining to make possible a large saving in cost of proposed relief sewers. In addition to the increased carrying capacity of sewers so lined, the sewer structure is obviously made stronger by filling in the joints of the old masonry in this manner.

A length of sewer was selected for the demonstration, in

INTERIOR VIEW OF FERRY STREET SEWER, ST. LOUIS, SHOWING OLD SURFACE BEFORE AND AFTER LINING WITH CEMENT GUN MORTAR.

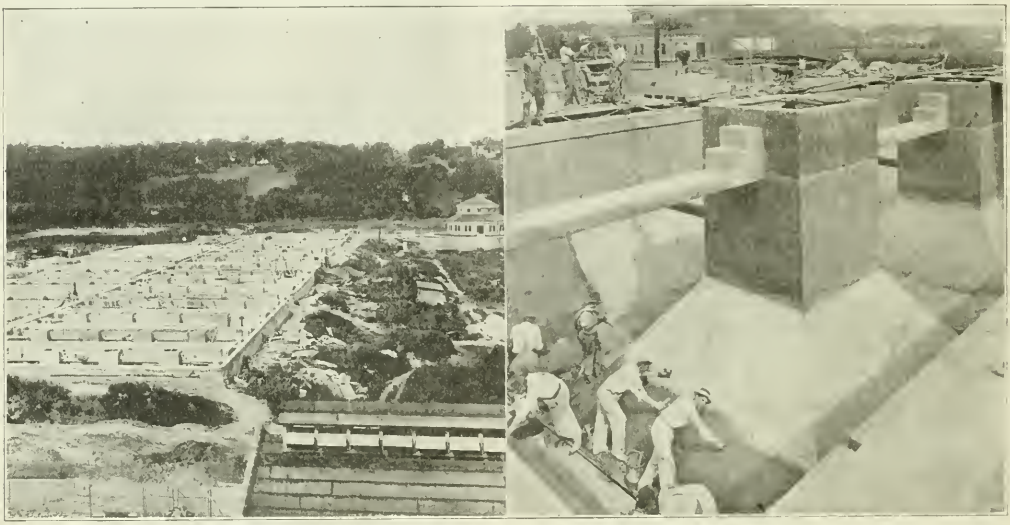
which were combined both ashlar and brick masonry, and which was of small enough diameter so that all parts could be reached without the use of scaffolding. Wire brushes were first tried for preparing the sewer walls for the mortar coat, but were not found satisfactory. The sand blast was also tried, but failed because of insufficient compressed air. The method finally successfully adopted was to pick and scrape the mortar out of the wall with a tuck-pointer's tool. It should be noted, however, that many old sewers are so thickly covered with foreign growths as to be unsusceptible to any scarifying method other than the sand blast, and sufficient air compressor capacity should be provided to convert the gun into a sand blower where necessary.

The St. Louis work was begun in the year 1915 and has been uniformly satisfactory. Many of the old brick sewers in that city were built with natural cement joints before the use of Portland cement became common. In many of these sewers the brick joints have been eroded to depths varying from several inches on the sewer invert to almost nothing around the sewer crown.

The sewers were treated with a mortar coating of the minimum thickness and were troweled where this was justifiable. Where the invert had disintegrated to a dangerous extent, the flow of the sewer was by-passed and the invert was reconstructed with vitrified brick up to the point reached by the gunite. On this work, both the gun and the compressor were operated on the street surface, while only the nozzleman, one signalman and the surfacers worked inside the sewer. Early in March of this year, Mr. L. Chivvis, Principal Assistant Engineer of Sewer Design, at the request of the editor, made another inspection of the work done by the cement-gun on the Ferry Street sewer in St. Louis, in 1915. This lining, he reports, most of which was put on without previously roughening the walls with a sand blast, is today in perfect condition. He advises that the present views of the St. Louis engineers on the utility of the process are very favorable, and they would probably be using it exclusively but for the present high cost of material and labor. A view is shown herewith of the lining placed in the St. Louis sewer by means of the cement-gun.

Mr. O'Shaunghnessy states further that the bond between the cement plaster and the concrete wall was found to be perfect. Even when a hole was chipped through the plaster into the wall, it was difficult to find the joint between the plaster and the concrete, and upon attempting to chip the plaster off from the wall with a cold chisel and hammer, the plaster was found to be thoroughly bonded to the concrete.

Following the successful application of this process on the Twin Peaks Reservoir division wall, the engineering department of the City of San Francisco has used the cement-gun for plastering in both the inside and the outside walls of a car barn for the Municipal Railway and for a reinforced concrete building constructed for housing a garbage incinerator. Mr. O'Shaunghnessy states that in all these cases he found the adhesion between the plaster and the cement to be perfect, and he considers the work far superior to any hand plastering which has come under his observation.



CONSTRUCTION VIEWS OF SEWAGE TREATMENT WORKS AT ALBANY, N. Y.

Left: General View of Plant. Right: Plastering Concrete Surfaces in Settling Tank with Cement Gun Mortar; One Gun Keeping Five Masons Busy Troweling the Surface.

San Francisco, California

One of the first applications of the cement-gun in water works construction was the case of the water-proofing of the division walls in the Twin Peaks Reservoir in San Francisco. Mr. M. M. O'Shaughnessy, City Engineer, states that early in the year 1912, it was decided to attempt to make a concrete wall dividing two halves of the reservoir water-tight by means of cement plaster applied with a cement-gun. This wall was of reinforced concrete 280 ft. long on top, 16 ins. thick at the bottom, 10 ins. thick at the top and 27 ft. high.

When one-half of the reservoir was filled with water, to a depth of 8 ft., the water seeped through the wall and ran down into the other half of the reservoir. The reservoir was emptied and both sides of the wall plastered with cement plaster about ¼ in. thick, applied by means of a cement-gun. After standing for about five days, the west half of the reservoir was then filled to a depth of 26½ ft. and kept filled for five days. During all of this time, the surface of the wall on the unfilled half of the reservoir showed no signs of dampness, indicating that the cement plaster was absolutely water tight.

Miscellaneous Examples

A reservoir at Muscatine, Ia., was built several years ago, partly on a fresh fill. This fill settled and the reservoir wall broke down to such an extent that the reservoir could not be used. The concrete lining was badly damaged. Repairs were made with the cement-gun, which proved to be highly successful.

The wash water tower at the Torresdale Water Filtration Plant in the city of Philadelphia, was becoming dangerous due to the leakage of water along the lines of separation between successive days work in the original concreting operations. This seepage water froze and caused the spalling off and disintegration of the concrete. In 1916, a contract was let for the repair of this tower, it being specified that the inner walls should be dried, cleaned and coated with a 5-ply membrane water-proofing, over which 2 ins. of reinforced cement-gun mortar should be shot on. On attempting to place the water-proofing membrane, it was found that no adhesion could be obtained on account of the damp walls. The membrane was then painted and the walls were lined with 1 in. of gunite, and reports indicate that all leaks from the tower are permanently stopped.

The city of Elmira, N. Y., built a large reservoir in 1911.

In 1916, the concrete walls had disintegrated to such an extent that in places pits were found from 3 to 4 ins. deep behind the reinforcing rods. A contract was let in 1916 for repairing this structure with the cement-gun and this proved quite successful.

An interesting application of the cement-gun process was made in the construction of the new reservoir of the Anaconda Copper Company at Great Falls, Montana. Instead of following the usual practice of lining a concrete reservoir with 1 to 2 ins. of reinforced gunite, the engineers of this company, Messrs. W. C. Tanner, Chief Engineer, and W. G. Capron, Asst. Chief Engineer, decided to line the basin entirely with gunite, with two layers of reinforcement. Reports of this work indicate great success in procuring an absolutely water-tight reservoir and also in getting this result at a very low cost, as the use of all transporting and other heavy machinery, as well as forms, was eliminated.

WATER WORKS DESIGN AND CONSTRUCTION

The New Mayfair Pumping Station of the Chicago Water Works

The Mayfair Pumping Station of the Chicago water works, is located at Wilson Avenue and North Lamon Avenue. It will supply water to the extreme northwest part of the city and will also maintain a high pressure system for high level territory. Work on this station was commenced in September, 1915, and, at the time of writing (May 15), it is expected that the station will be placed in operation on June 1, 1918.

The building fronts south on Wilson Avenue, with a pump room 236x60 ft., the floor being at elevation 7.15, or 38.65 ft. below street grade. There is an office section one story high, 50x31 ft., in the center of the south front. The boiler room, 204 ft. by 54 ft. 9 ins., lies north of the pump room. The basement level at elevation +13.92 is 17.58 ft. below street grade and the main floor, at elevation +28.84, is 2.66 ft. below street grade. A coal receiving room, 72 ft. 9 ins. by 70 ft. 9 ins., is located north of the boiler room, leaving an 18-ft. driveway between the two.

A sidetrack turning south from the C., M. & St. P. Ry. will carry coal cars into the receiving room over three receiving hoppers. The coal can be unloaded directly into the hoppers through bottom dump cars or by means of a grab bucket from an overhead traveling crane, or the coal can be stored in bins on both sides of the track hoppers.

The coal, after passing through a crusher under the hoppers, is carried south on an apron conveyor to the main bucket conveyor running east and west in the boiler room 4 ft. north of the boiler fronts. This conveyor supplies a set of enclosed bunkers 17 ft. 6 ins. long, which have a capacity of 1,000 tons. Spouts feed the coal from the bottom of the bunker 22 ft. above the boiler room floor to each stoker.

The boilers, which front north, supply steam at 175 lbs. pressure through a double header system to the seven pumping engines. The steam for the pumping engines is supplied by a battery of six four-pass Edge Moor water tube boilers equipped with Taylor stokers.

The smoke breeching is suspended from the main floor and enters the central stack from the east and west. The stack is 184 ft, 2 ins. high above the boiler room floor, inside diameter 8 ft. at top and 14 ft. 5 ins. at base and is supported by four 5-ft. caissons extending to solid rock at elevation —50.0.

CONSTRUCTION VIEWS OF MAYFAIR PUMPING STATION, CHICAGO WATER WORKS.
Left: General View of Station Looking Southwest; Photographed July 12, 1917. Right: Interior View of Pump Room Looking West, as Photographed April 24, 1917.

The water is pumped by seven pumping engines of a total capacity of 152.5 million gallons per 24 hours. The pumps are triple expansion crank and flywheel type, with mechanically operated suction and discharge valves of Riedler design. Water is to be conveyed to the station from Lake Michigan through the new Wilson Avenue Tunnel.

The steam ends of both high and low pressure pumps are alike, but the water ends of the three west pumps are smaller. The three west pumps will each deliver 17.5 million gallons per day against a 200-ft. head, and the four east pumps will each deliver 25 million gallons per day against a 140-ft. head.

Each pump has two suction nozzles extending south and

then down into a common suction tunnel, whose flowline is 20 ft. 10 ins. beneath the pump room floor. All the water entering the pumps passes around the tubes of a surface condenser and is discharged through four pipes from each pump into the two station mains.

There are two discharge mains for the 140-ft. head, one north and one south of the pumps at elevation -4.0, extending the full length of the station, leaving at the west. They are supported by a series of piers adjacent to the north and south walls. The two high pressure lines start at about the center of the building and are supported by saddles on the other pipe and also leave at the west.

Immediately west of the station are two pipe vaults, in which the pipes rise to street grade and change direction to conform with the general layout of the street pipe system.

Contracts

The J. U. Boland Construction Co. was given the contract for the chimney on the alternate design of a concrete bore, veneered inside and outside with brick, at a total cost of $10,480. The City built the four chimney caissons and slab. The circular base from the slab at elevation +9.00 to elevation +33.84, which was part of the chimney contract, was also built by city day labor under force account work for the contractor.

The Lakeside Bridge & Steel Co. was given the contract for all the structural steel. The pumping engine contract was executed by the Allis-Chalmers Manufacturing Co. of Milwaukee.

Personnel

The engineering work at this pumping station during its construction, was in local charge of F. Carl Martini, Assistant Engineer. Henry W. Clausen is Engineer of Water Works Construction. John Ericson is City Engineer.

Present High Prices on Water Works Materials Will Continue After the War

By Robert E. McDonnell, of Burns & McDonnell, Consulting Engineers, Interstate Bldg., Kansas City, Mo.

After-the-war prices of water works materials have greatly concerned superintendents of both municipally and privately owned water plants; but, now that the war is in its fourth year with no end in sight, the public is gradually adjusting itself and becoming reconciled to war prices. The water works officials who have withheld improvements and postponed purchases now find themselves in a sorry plight by facing a prospect of still higher prices after the war. Had the war been of short duration things would have been different. The war has already lasted long enough to establish new economic conditions that will not be changed soon when the war is over, said Mr. McDonnell, in addressing the Southwestern Water Works Association.

Labor Question

The price and availability of labor, both skilled and unskilled, is one of the chief determining factors of prices. Mechanics and skilled workers in pump factories, valve and hydrant factories, meter factories and pipe foundries are now receiving about twice to three times their former wages, and the laborers having once accustomed themselves to short hours and high wages, new habits of living are formed. Imagine in your own case what you would do if after enjoying for several years $200 per month, you were required to readjust your affairs to a salary of $150 per month. You probably would not accept it, but engage in something else of a similar nature. Labor of unskilled kind would not be content with reductions, and the labor that has gone to war, will, upon coming back, be of an entirely different character from what it was when it left the water trenches for the fighting trenches. A few years fighting for his country, seeing new lands, new cities and mingling with intense activity will completely transform the man to one of higher ideals and aspirations. He will no longer be content with the menial tasks. He will learn that he is capable of doing bigger things. The contractor, the farmer, the foundryman and the manufacturer who are looking for their labor back again after the war will look in vain, for their mental, moral and physical changes will be so great that the men who return will have other things in view.

Labor cannot help being the scarcest commodity in America for at least several years after the war. Previous wars, although trifles compared to this war, were examples of producing a scarcity in labor for years following their close.

Post-War Foreign Attractions for Americans

A wonderful equalizing effect will also result. The restoration of ruined cities in Europe will attract American engineers, contractors and material dealers. We are now, as a result of our new knowledge of the world, bidding on foreign work with the same keenness as if the job were in an adjoining city. The immense merchant marine now used for war purposes will, after the war, convey labor and materials readily to every part of the world. France, South Africa or Egypt will then be almost as accessible as remote parts of America.

American Water Works Materials Much Wanted Abroad

Foreign countries will not have the barriers that formerly existed. Our machinery, pumps, pipe, meters, filters and supplies of every description have since the war started been tried out abroad and are so well liked that American factories are now busily engaged in shipping water works supplies to China, South Africa, Palestine and all South American Republics; in fact, all over the world. Our mechanical filter plants have so pleased the South American countries that they will not be satisfied with any other. One of our own assistant engineers now in Uruguay supervising the installation of a water works, lighting and sewerage system writes that the Uruguain officials are so well pleased that American engineers, contractors and materials will have the preference. These markets opened up since the war are not going to close after the war.

A demand has been created that will continue, and *demand* is one-half the cause of price making. If the labor to produce the supply is going to be scarce we then have a scarcity of supply and an increase in demand—two functions that tend to maintain high prices.

The Unwise Waiting Policy

Many cities have waited and continued to wait, expecting lower prices. Cities requiring water purification plants have continued to use polluted supplies, thereby endangering the health of their citizens, all because of a mistaken idea that prices would be lower right after the war. Fire protection equipment both in pumps, larger mains and fire apparatus, has been postponed awaiting lower prices after the war, until now we have inadequate fire protection in many cities. This condition, already alarming, is made doubly dangerous by the frequency of incendiary fires throughout the country. The holding off of these improvements until after the war would increase the normal demand to the point of producing an increase in prices following the war. Cast iron pipe, the largest item of cost in water works construction, is held down in price now only by the governmental control of the pig iron price, and with foundaries already petitioning the government to permit an increase one can readily see that with the governmental control removed the price would immediately go upward. The same is true of the copper market control. The demand for copper was never greater than at present in the history of the world and when the government regulation of the price is removed copper will immediately go upward to meet the demand.

Waiting Cities Will be Disappointed

Cities, therefore, holding back lighting improvements or electrifying their pumping plants in anticipation of lower

prices, are going to meet with disappointment. The war demand for water works materials has been no greater than similar demands for all classes of commodities. The use of American materials in the war has served to demonstrate their adaptability which in itself will create new markets. One of the remarkable achievements of the war accomplished through American water works materials, was the capture of Palestine from the Turks. The capture of Palestine in the past was attempted many times in the last 1400 years, and the British attributed the failures to the lack of water supply. With the use of American made pipe, pumps, valves and equipment, a 10-in. pipe line was laid 150 miles across the desert, supplying drinking water for the troops, camels and munition trains. The pipe was carried in by camels and water was made available for use as the pipe laying progressed.

Prices After Other Wars

Facts taken from history give excellent precedents as to what we may expect in the future prices. In the period covered by the French Revolution, America was also engaged in war with England, so that at that period practically the whole civilized world was at war. While business was small then, yet prices went through the same performance they are repeating today. Prices after the war rose and remained at the maximum during the war for a period of about five years after the close of the war. In 1864 the increase was about 50 per cent. above the normal of 1851. The decrease toward normal was only about 20 per cent., covering several years with a sharp increase again at the Franco-Prussian War in 1871, and the prices did not return to normal until 1880, ten years after the close of the Franco-Prussian War.

View of New York Board of Water Supply

Prices in time will undoubtedly seek their normal level, but cities, like individuals, need water for their growth. Can we afford to stunt the growth of a community by waiting for lower prices? This question has been carefully studied by those most competent to pass opinion. Recently a report was made by the New York Board of Water Supply to the Mayor of New York, which states "That there are no convincing evidences that labor and materials will be less expensive now or for several years to come," and further makes the suggestion that "many well informed persons are of the opinion that the tendency will be higher and still higher prices for water works commodities." The report closes with the recommendation that the city's interests will be best served by the continuous and speedy prosecution of the water works improvements to their final completion.

Water is fundamental to the growth and prosperity of every community. An abundant supply of good pure water is a city's most valuable asset. Its industries cannot be secured or maintained if the water supply is inadequate.

The Capital Issues Committee of the War Finance Corporation in giving approval to water works bonds has gone on record as to water supplies and their improvement, as being an essential improvement, and all worthy projects are meeting prompt approval.

The essential feature in the whole problem to consider is the responsibility of the water works profession toward the health of the community. Nothing has such a great bearing upon the health of the community, as the quality of the water. Can the water boards, mayors, superintendents and engineers afford to defer improvements when that postponment may mean an epidemic of typhoid or other water borne disease? The loss of lives cannot be justified by a saving in dollars.

Some Design Features of the Waban Hill Covered Reservoir of the Newton, Mass., Water Works

By Edwin H. Rogers, City Engineer, Newton, Mass.

The extension of the covered water works reservoir on the summit of Waban Hill, in the city of Newton, Mass., as designed by and constructed under the supervision of the city engineer's department, was completed on November 30, 1917, except for the installation of certain gates and piping within the gate chamber.

The reservoir, as now extended and completed, comprises four rectangular sections, with a circular chamber at the center, in which are installed a steel distributing tank and pipes from the force main to the different sections and the overflow pipes and drains for emptying the different sections.

The Four Sections of the Reservoir

Section 1 is the southeasterly section and was built in 1890; section 2 is the southwesterly section and was built in 1901; sections 3 and 4 are the northwesterly and northeasterly sections, respectively, and were built in 1916 and 1917.

The types of construction of sections 1 and 2 are nearly the same, whereas the design adopted for sections 3 and 4 is radically different from the older type. Sections 1 and 2 are built with rubble masonry gravity walls extending 3 ft. below the floor of the reservoir, the roof of these sections being supported by brick columns on rubble masonry foundations below the floor. The roof of section 1 is brick cylindrical arches, supported by other arches at right angles springing from column to column, and the roof of section 2 is of reinforced concrete flat slab construction, supported by longitudinal steel I-beams spanning the distance between the columns and walls. All of the sections have the roof covered with loam.

Design of New Sections

Sections 3 and 4 are built of concrete throughout, the walls being 2 ft. to 2½ ft. thick at the top and 4 ft. thick at the bottom, and the walls as well as the columns are constructed of it and rest directly on the floor, which is a concrete slab 12 in. thick under the walls and a short distance inside, and 8 in. thick under the rest of the structure. The walls are reinforced so as to act as a beam to resist the earth pressure of the embankments, and the floor under the walls is reinforced at the corners. The floor under the columns is reinforced by a grillage of steel rods, thus distributing the load on the columns in such a manner as not to exceed a suitable pressure per square foot on the supporting soil. The floor was further reinforced by 6x6-in. galvanized Clinton wire cloth lapped at all joints, to distribute temperature stresses occasioned during construction. The floor is level, at grade 305.27, Boston City Base.

The roof is of groined arch construction without reinforcement, the intrados being semi-elliptic with a rise of 3 ft., the extrados being parabolic with a drop of 9 in. over the columns, the thickness of the arch at the crown being 6 in.

The columns are without reinforcement except for dowels at their bases connecting them to the floor and pintles at their tops running into the haunches of the arches.

The walls were reinforced longitudinally sufficiently to prevent cracking between the expansion joints, which were inserted at intervals of from 30 to 35 ft. These expansion joints are provided with a folded sheet lead dam to prevent leakage and a sheet steel dam is provided between walls and the floor for the same purpose.

Cast iron ventilators with openings consisting of narrow slits are provided in the roof, and one cast iron manhole in each section provides access for inspection and cleaning.

The 24-in. cast iron inlet pipes enter the sections at the flow line, continue of cast iron on a slant to the floor, and are extended along the floor of vitrified pipe construction imbedded solidly in a concrete base. The flow line is at grade 320.27.

The sections are covered with filling and loam 18 in. in thickness over the crowns of the arches, and embankments on a 2 to 1 slope are built adjoining the outside walls and covered with 12 in. of loam. The excavation for the site of these sections was done largely with a steam shovel and horse-

drawn dump carts, the material excavated from the site providing the greater portion of the filling and loam required.

Construction Plant Employed

The construction plant consisted of a wooden tower over 100 ft. in height, erected on the northerly side of the sections No. 3 and 4, opposite the retaining wall between them, with the concrete mixer at its base, and bins for the storage of the sand and stone on the northerly side of section 3, whence the aggregate was conveyed to the mixer by an industrial railway operated by a cable from a stationary engine which furnished the power for the mixer and the elevator in the tower. Chutes from the tower in several sections were provided of lengths sufficient to reach to any part of the work and were used for placing most of the floor and walls. These chutes were difficult of operation unless a large percentage of water was used in the concrete, and so their use was abandoned for the placing of the columns and roof work, in which a dryer mixture of concrete was advisable than used in the floor and walls.

The concrete for the columns and roof was dumped from the tower directly into steel concrete barrows or buggies and pushed by the workmen where required.

Wooden forms were used for the walls, steel forms for the columns and the capitals of the columns part way up the arches, and wooden forms for the balance of the groined arches, the latter forms being supported by wooden posts from the floor.

Crushed stone was used for the coarse aggregate in the concrete and the sand and cement were frequently tested and found to meet the specifications in each instance.

The floor was finished by the use of a roller made of a 3-in. pipe, a method which has since been adopted in many instances for the finishing of concrete roads. The walls and columns were washed with grout after the forms were removed.

The capacity of the sections of the reservoir with the water at the full depth of 15 ft., are approximately as follows:

Section 1, 2,300,000 gals.; section 2, 2,200,000 gals.; section 3, 3,000,000 gals.; section 4, 2,900,000 gals.

Cost

The work of relocating the water mains in the vicinity of the reservoir, the furnishing of the iron castings for ventilators and manholes, the furnishing and installation of the piping and other incidental work, was done directly by the water department forces at a cost of $5,252.92; the cement gun work was done by John O. Ballentine, of Peabody, Mass., at $700; the balance of the work, which included all excavation and grading, concrete construction, furnishing of reinforcing bars, form work, and all work incidental thereto, was executed by the Old Colony Construction Company, 6 Beacon street, Boston, at a contract price of $59,699.40. The contract of the latter company was dated June 8, 1916, and was prosecuted to successful completion in the face of rising prices of labor and material, and at what was obviously a substantial loss to the contractor.

Methods Employed in Reconstructing Fort Madison, Ia., Water Works Plant on Exact Site of Old Plant Without Interrupting Operation

The water works plant of the Fort Madison, Iowa, water works system was recently completely reconstructed on the exact site of the old plant without any interruption to the water supply whatever.

During this reconstruction process, every bit of the material and equipment in the old plant was replaced with new material and equipment. Naturally this was a piece of engineering work calling for unusual preliminary planning and study and also for a careful handling of the construction materials and methods.

While it is not an unusual thing to replace an old steel bridge with a new one without interfering with the traffic, it must be remembered that in bridge work a short interval at least is had between the successive passage of the trains or vehicles using the bridge, but in supplying water to a city of 15,000 people, with continuous water service, there can be no interruption to the supply, even for a minute without jeopardizing property and public health as well.

It is a fact that cities oftentimes contemplate the reconstruction of an old water plant, but hesitate to undertake this work because of the fear of interrupting the service, realizing that such interruption will result in criticism of the officials in charge.

At Fort Madison, however, criticism had reached an advanced stage because of the quality of the water supply and the inadequacy of the fire pressure, so the city officials decided to rebuild the water plant to secure a better quality of water and better fire service.

As the city was unable to issue bonds to defray the cost of building a municipal plant, 25 of the leading citizens organized the Citizens Corporation, which was granted a franchise, immediately took hold of the old property, and began the reconstruction of the water works plant at an expenditure of about $300,000.

The old plant had not operated at a profit, so the new corporation was very desirous of making such changes in the plant, and in introducing such economies in operation, as would make the new venture a profitable one from a business standpoint.

The consulting engineers, Messrs. Burns & McDonnell of Kansas City, Mo., in preparing the plans and specifications for the requisite machinery and equipment for the pumping plant, power plant and filtration system, also kept in mind the unprofitable results of operation of the old plant, and made every effort to provide equipment that would give the best of service at a minimum operating cost.

It is obvious that the building of a new water plant on a new site with a new source of supply is quite simple in comparison with such a reconstruction project as that undertaken at Fort Madison. At this city the old station, like many old water plants, contained obsolete pumping machinery and a power plant that was wasteful of fuel. There was no check on wasteage of water, and due also to frequent changes in management, very uneconomical operating conditions existed.

The old station contained two high service pumps, but only one was in operating condition. The old brick station building was torn down from around the old pumps and boilers, and the equipment was covered with canvas, and excavation for the new structure was started. Practically the entire work of reconstruction was carried on during severe winter weather. In making the excavation for the new structure, it was found necessary to take up the old discharge lines from the pumping plant and to replace them with temporary connections.

The first work undertaken and completed was the construction of a 1,000,000-gal. reinforced concrete storage reservoir to provide some storage of water in case of interruption in pumping. One old boiler was disconnected and discarded; foundations were built and the new boiler was then erected and put in operation. Then the second old boiler was removed and foundations were built for the second new boiler, which was then connected and enclosed in a new steel casing.

A temporary smoke stack, made of old corrugated iron culvert pipe, was erected and supported above the boiler by structural steel frame taken from the old building. This temporary stack was also supported by guy wires placed so as not to interfere with the later work of placing the roof trusses and other building operations. A complete new stack was erected, and as soon as the new boilers were placed the new breeching was put in place and connected to the new stack.

While these changes were being made, the building was being constructed, and firemen, engineers, and other operatives were protected by canvas covers stretched over frame work above the boilers and pumps and, despite the severe winter weather, this work was carried on without interruption.

In the pump room a new concrete foundation was erected, and the new pump installed. New steam connections were at once made and the old pump was dynamited. This old pump had seen about 32 years of service and had twice been welded together to keep it in operation, so it was not considered of sufficient value to save. Fortunately, the new pump had all of its connections completed and was ready to be placed in service when the old pump broke down completely. Steam was then turned into the new pump immediately after the collapse of the old pump, and continuous service was maintained, with scarcely an interruption except for a few minutes for making adjustments to the new pump.

The new high service pump is of the Corliss Fly-Wheel type, and because of its high efficiency, is kept in continuous operation, and for emergency use, a 3,000,000-gal. duplex pump of lower efficiency is used, and on this unit the first cost was less than on the high duty pump.

The low service pumps are motor driven and are in duplicate units, consisting of two 3,000,000-gal. units, delivering the water from the intake of the Mississippi River into concrete lined settling basins, from which the water flows through four 750,000-gal. capacity mechanical filter units. Duplicate generating units are provided for generating the electricity for operating the low service pumps and also to furnish power for the operation of the blower and wash water pump used in the water filtration plant and also to furnish electricity for lighting the entire plant and grounds.

In this installation, the equipment was selected so as to make certain the highest obtainable operating efficiency. In operating, all the coal is weighed on permanently installed scales, and the boiler feed water is weighed with an automatic recording device that determines the amount of water evaporated for the quantity of coal used, and a constant check is thus obtained on the amount of steam produced by a given amount of coal. The ability and faithfulness of each fireman is easily learned by an examination of these records. The records are so arranged as to show at a glance the results obtained from day to day throughout the year with reference to the amount of coal consumed, the amount of water evaporated, the amount of water pumped and the cost of fuel per thousand gallons of water pumped. This system of record gives the superintendent a means of checking up from month to month on the performance of the individual firemen, and he can hold them up to a high mark, or replace them.

VIEW OF RECONSTRUCTED WATER WORKS PLANT AT FORT MADISON, IOWA.
Pumping Station and Coal Storage on Right. Settling Basin, Filter House and Head House on Left.

A new intake was built into the Mississippi River. Its construction was made necessary on account of the building of the Keokuk Dam which had raised the level of the water in the river at Fort Madison about 15 ft. and it was desirable to place the new intake above the bottom of the river in order to avoid drawing in sediment.

Between the low service pumps and the filtration plant all water is metered. This is desirable because centrifugal pumps constantly in operation with water containing sediment lose their efficiency, and a continual check is desired so as to determine when new impellers should be placed in these pumps.

To get an additional check on the wasteage of water, all the water is metered in passing from the high service pump to the steam reservoir and into the mains. This double check on both high and low service delivery enables a prompt de-

termination to be made of the amount of leakage and prompt remedial measures can be adopted when wasteage is detected. The water distribution system comprises two miles of cast iron mains, and universal meterage is being adopted.

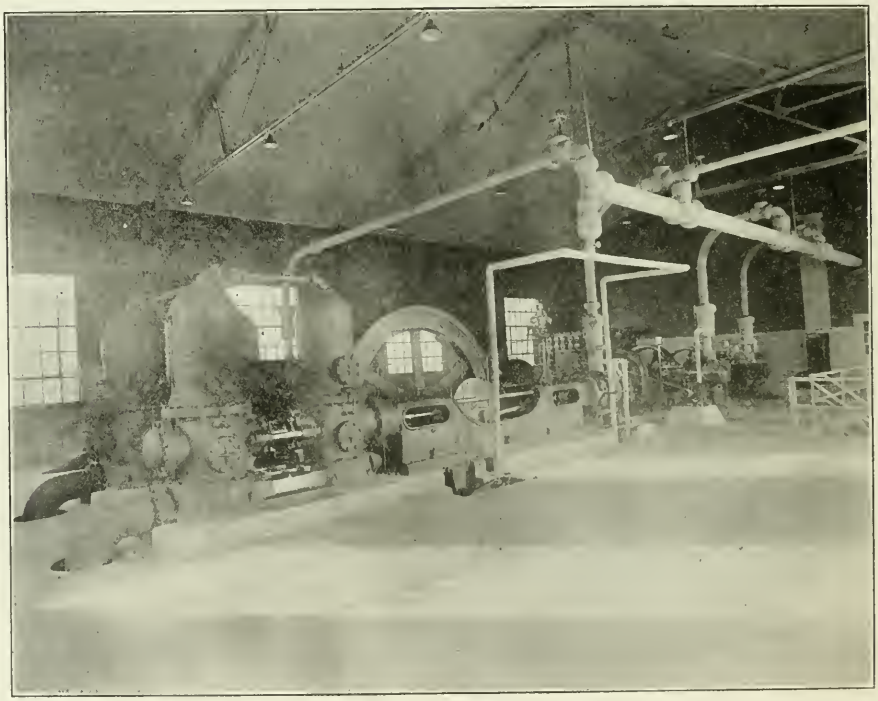
The water purification plant consists of reinforced concrete settling basins and a mixing chamber into which the coagulant is fed with dry feed machines which avoid the trouble of mixing with mechanical solution tanks and the trouble with the agitators in solution tanks. The sulphate of alumina is fed in a pulverized form and goes into solution in the mixing chambers. Storage for chemicals is provided on the third floor of the filter house in carload capacity. Because of the efficiency of the scheme of storage and the dry feed machines employed, the plant is free from the disagreeable odors some times present at a water purification plant.

The concrete settling basin was built on a fill consisting of a creek deposit. Because of this, the settling basin was placed on a large reinforced concrete slab, the reinforcing consisting of about 75 tons of old steel rails Although the basin has been in operation for about a year, measurements recently taken show that the settlement has been less than ⅛ in. This certainly indicates the success of the new slab foundation, as, in addition to the creek deposit at the site, a saw mill once operated on the same site, and a large amount of saw dust remained in the soil underlying the basin, which therefore, did not provide good supporting qualities.

The water flows by gravity from the settling basin into four 750,000-gal. mechanical filter units, installed by the Pittsburgh Filter Manufacturing Company. The filters are in one row. The filter gallery under the filter floor has all its pipes and valves readily accessible to the operator, and provides plenty of head room and working space, with all the piping arranged on one side of the gallery.

Because of the unusual difficulties of construction and the hazardous nature of the undertaking from a contractor's standpoint, this contract was awarded on a cost-plus-a-percentage basis to the Wodrich Construction Company of Minneapolis, Minn. This plan of handling the work proved mutually satisfactory. The pumping and power plant equipment was furnished and installed by the Merkle Machinery Company of Kansas City, Missouri, and much of the installation of this equipment was also erected on a cost-plus-a-percentage basis.

Recent tests of the filtered water by the state chemist, show a reduction of bacteria, amounting to 99¾%. Three separate tests have also been made by the state chemist, who has found no trace of dangerous bacteria or disease germs in the water. The only chemical coagulant now being added to the water is the sulphate of alumina, and because the results are so satisfactory from the hygenic standpoint, the consumption of water has increased rapidly since the new plant was placed in operation some eight months ago. As a further precaution to the water treatment process, liquid chlorine sterilization of the filtered effluent is practiced.



INTERIOR OF PUMP ROOM, FORT MADISON (IOWA) WATER WORKS, SHOWING HIGH SERVICE CORLISS ENGINES.

Seven miles of new pipe lines were added to the distributing system, and by making use of old gate valves, these extensions were installed with but slight interference in various parts of the residental district. Large reinforcing mains were also laid in the business district and a duplicate supply line was installed, connecting the main pump plant with the distributing system in the business district and the new mains were laid by Stephen Schults of Fort Madison, and were placed in service almost as fast as laid, as the corporation desired to secure revenue as each block of extensions was completed.

The entire engineering work, including the preparation of plans, specifications and supervision of construction, was

handled by the firm of Burns & McDonnell, consulting engineers of Kansas City, Mo. Mr. C. E. Painter was supervising engineer on construction, and remained in charge of the operation of the plant.

Use of Condensing Apparatus in Water Works Plants

The Editor of MUNICIPAL ENGINEERING:

Sir—

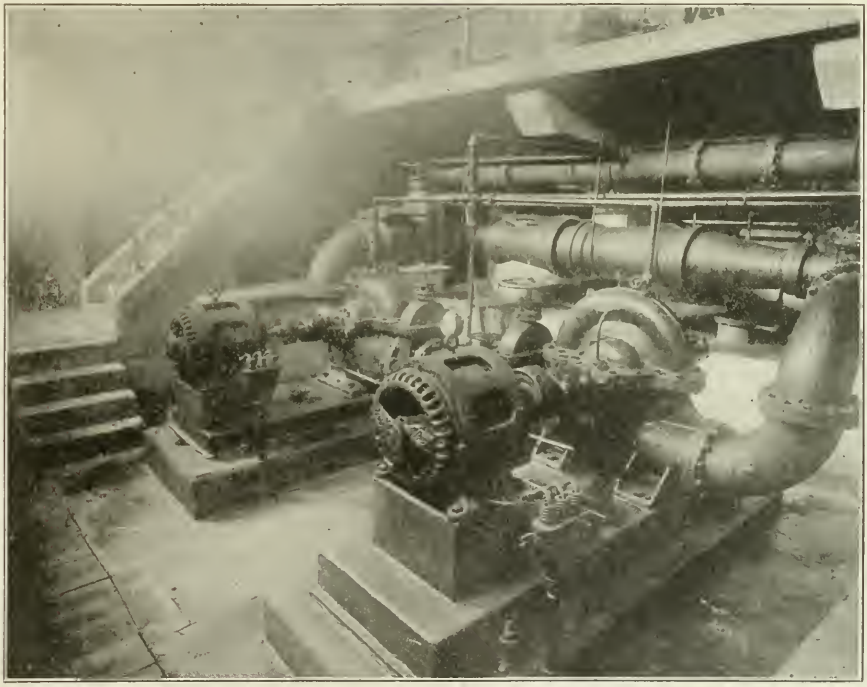
We believe there are few engineers in water works plants who have not carefully studied and in many cases taken advice upon their existing condensing apparatus and the economical possibilities of modifying or improving it. There are many existing plants where the type and design of engine with its valve areas, port areas, etc., would prevent realization of higher economy with improved vacuum.

There can be no question as to the thorough discussion of this feature in the case of the proposed installation of new apparatus, as it must necessarily be carefully considered by any consulting engineer, and would be thoroughly discussed by the builders of pumping apparatus, who would be desirous of utilizing their latest economical improvements to the fullest extent permissible, provided the specifications so permitted.

High Vacuum Obtainable in Water Works Plant

There is one point which is perhaps not sufficiently realized or appreciated, viz: for the same amount of power developed, a water works plant is capable of obtaining much higher vacuum and consequently better economy than any other type of power plant. One of the most serious questions in the selection of a site for a large power plant, especially a lighting or power station, is the availability of sufficient condensing water and the possibility of satisfactory arrangement for its utilization. Smaller power plants must usually be satisfied with a location which they know will not permit of realizing the highest economy. In the commercial power plant, both the quantity of water and the power economically available for handling it are limited.

In the case, however, of a water works installation, a surface condenser can be placed in the suction or discharge main at the point that best conveniences the general layout, and the quantity of water is from 15 to 20 times that available for condensing work in a commercial plant. This means that the temperature of the water passing through the condenser is raised, say, 1 degree instead of 15 to 20 degrees with consequent reduction in the temperature and corresponding pressure in the steam space. In fact, with the same temperature of water, it should be readily possible to maintain .3 to .5 in. better vacuum with the water works type of condenser, which would result in an improved economy or duty of from 3 to 5 per cent. at least.



TWO 3,000,000-GAL. MOTOR-DRIVEN, LOW-SERIVCE PUMPS, FORT MADISON (IOWA) WATER WORKS.
These Pumps Lift Water to Settling Basin, and It Flows by Gravity to Four Mechanical Filter Units.

Results at Sixty-Eighth Street Pumping Station, Chicago

Your readers are familiar with the duty trials of the two 30,000,000-gal. turbine driven centrifugal pumping units recently installed by us at the 68th Street Pumping Station in Chicago, as described in MUNICIPAL ENGINEERING for October, 1917, where a vacuum was maintained corresponding to between 1 and 1.5 ins. absolute at the turbine exhaust nozzle when operating at capacities between 17,000,000 and 42,000,000 GPM. In this plant water from the main was utilized for operating the auxiliaries, thus realizing for that purpose the economy of the main pumping unit itself and requiring at maximum capacity only approximately 1½% of the main turbine power for driving the auxiliaries. In this case, to have met the same guarantee of condenser performance as in the case of a commercial

turbine of the same power, we should have asked for approximatly 1,600 GPM of circulating water instead of the 30,000,000 gal. capacity or approximately 21,000 GPM available in this instance.

The surface is not quite as efficient in heat transmission in the water works type of condenser as in the commercial type, for the reason that in the latter, the water passes uniformly through the tubes and over the surface at a velocity which permits it to carry away the heat efficiently, whereas in the water works type, the water passes in a less efficient manner over the outside of the tubes, which are arranged to cause an inappreciable loss of pumping head.

Worthington Pump and Machinery Corporation,
May 9, 1918. 115 Broadway, New York.

Water Purification and Sewage Treatment

The Development of Sewage Treatment

By Kenneth Allen, Sanitary Engineer, Board of Estimate and Apportionment, New York, N. Y.

Review of Past Development

The disposal of human waste is a problem that has confronted cities and towns from times immemorial, but it is only within the past 70 or 80 years—nearly coincident with the introduction of water closets—that sewerage as we now know it, with its problems of disposal, has been a factor in municipal sanitation.

Early Aspects of the Problem

At first it presented itself as a problem of the removal of excretal matter, at first by itself and then together with surface and subsoil water, from the immediate vicinity of habitations; but as water courses became more polluted, secondary nuisances arose impelling action toward their amelioration. In a report of the Royal Sanitary Commission, published in 1875, it was stated that it was the serious outbreaks of cholera in 1831, 1851 and 1866 that "led to investigations of the means of preventing infectious diseases, and so drew attention to the fact that the *seats of endemic diseases are generally where the air or water is polluted.*" And so, with no knowledge at the outstart as to the underlying principles governing the development of nuisances and the dissemination of the germs of disease, progress, though slow and irrational, was being made.

Pioneer Disposal Methods

It was early recognized that sewage had a certain value as a fertilizer; in fact, excreta had been used in this way for centuries, so that sewage farms, especially in England, where ideas of sanitation were most advanced, sprang up; and later, as involving the use of less land, there followed the primary removal of solids by settling in tanks, rendered more effective later by the use of precipitants.

About this time—in the seventies—experiments by Frankland and Bailey Denton in England demonstrated the possibility of sand filtration, followed by the discovery of Schloesing and Muntz, in France, that the purification effected was due to micro-organisms.

In the eighties, by the investigations of Warrington, Dibdin, Dupre, and last, but not least, the classic experiments of the Massachusetts State Board of Health under the guiding hand of Hiram F. Mills, the true theory of the agency of bacteria in purification was placed on a firm foundation; and from that time progress in sewage disposal has been established on a rational basis.

Anaerobic Decomposition

In 1878 Dr. Muller, of Berlin, obtained patents involving anaerobic decomposition for the wastes from beet sugar factories, and four years later Mouras patented his "automatic scavenger" in France, a device which he had used in his house for 20 years and which was the forerunner of the septic tank of today. But it was not until Cameron built his septic tanks at Exeter, England, in 1895 and 1896, that the principle of getting rid of the organic solids by liquefaction was adopted by a municipality.

In the next 15 years the septic tank was greatly in vogue in England and America, and today it leads the list in the latter country. It is interesting, now that we are so familiar with its limitations, to recall the optimism with which its introduction was first received. At an inquiry of the Local Government Board of Great Britain at Exeter, in 1897, the effluent was described as "a really colorless fluid, free from deleterious properties, and fit to be passed into any river." Dr. Dupre testified that "everything that can be purified is already purified in the septic tank and filtrate and any change must be in the direction of additional purity undoubtedly."

The effluents obtainable from sewage farms and sand filtration areas were such as to meet all reasonable requirements,

LEFT: VIEW OF ACTIVATED SLUDGE AERATING TANKS, MILWAUKEE, WIS. RIGHT: VIEW OF IMHOFF TANKS AND TRICKLING FILTERS AT FITCHBURG, MASS.

but the majority of the plants in England comprised some kind of tank treatment.

Chemicals began to be used for precipitating the solids about 40 years ago, and a large proportion of the English plants today involve chemical precipitation. Over 500 patents have been issued in Great Britain for different precipitation processes, but in the United States the trend in recent years has been more toward the use of septic or Imhoff tanks.

Introduction of Oxidizing Filters

The effluent from all these tank installations, even if clear and sparkling when first discharged, was unstable and putrescible. A remedy for this was found by Dibdin in 1892 by treating the sewage at Barking (London) on contact beds, and the next year by Corbett in treating the sewage at Salford by trickling filters. By each device the dissolved organic matter was reduced to a mineral form and the effluent rendered relatively stable. The theory of these finishing or oxidizing processes had already been well established by the investigations of the Massachusetts State Board of Health mentioned above.

1. To prevent the objectionable appearance of streams;
2. To avoid the formation of sludge deposits;
3. To avoid the production of odors; and,
4. To prevent the dissemination of disease.

1. To Prevent the Objectionable Appearance of Streams Due to Floating Solids, Scum and Sleek

Scum and sleek are mainly due to the oily constituents of sewage. It is impracticable to avoid entirely the presence of sleek, although both this and scum may be reduced by skimming in a chamber or tank before discharge. The larger floating solids are much more objectionable, and where it is desired merely to remove these the standard operation is fine screening.

Various types of screens have been used, but their chief development has been in Germany. Within the past ten years two types have gained a foothold in the United States, the Weand and the Riensch-Wurl.

The Weand Screen

The Weand screen was first used at Reading, Pa. It consists of a horizontal cylindrical frame covered with a mesh

VIEWS OF SLUDGE DRYING BEDS AND TRICKLING FILTERS IN OPERATION, PHILADELPHIA, PA., SEWAGE TREATMENT WORKS.

The next important step forward was in modifying tank treatment so as to subject the sludge only to septic treatment allowing the sewage to pass through with a brief detention, as worked out by Travis in England in 1908 and Imhoff in Germany the following year.

Disinfection of Sewage Effluents

The effluent from all of these processes was a source of danger if introduced into water supplies, so that in 1905 Johnson and Copeland made tests at Columbus in the use of copper sulphate as a disinfectant. These were followed in 1907 by the use of bleach by Phelps at Red Bank, N. J., and up to the present time chlorine as bleach or in the liquid form has been used successfully for the disinfection of water supplies or sewage effluents by many towns.

These improvements were the last of a fundamental character to be adopted and established in standard practice up to the present time; but there have been several recent attempts to achieve more perfect results that are sufficiently important and promising to deserve mention.

Standard Methods of Sewage Treatment

With this brief review of the development of sewage disposal in the past we may clarify our ideas of the subject by considering categorically the chief reasons for treating sewage, with the methods most commonly employed:

of monel metal having about 36 strands per inch. The sewage enters one end, and, as the screen rotates, flows through the mesh, leaving the screenings inside to be automatically worked toward the farther end and removed through a chute. These screens have been installed, besides at Reading, Pa., at Baltimore, Md., Atlanta, Ga., and Brockton, Mass., in each case as preliminary to further treatment.

The Riensch-Wurl Screen

The Riensch-Wurl screen, brought into prominence by the excellent installation at Dresden, is employed in some 50 European plants, and within the past few years has been installed at Rochester, N. Y., Johnstown, Pa., Long Beach, Cal., Brooklyn, N. Y., and, during the past year, at Dyckman street, Manhattan. It consists of a bronze plate rotating on an axle usually inclined 15 or 20 degs. from the vertical, and surmounted by a truncated cone of the same metal. The plate and cone are perforated with slots, which, in the Dresden screen, are .08 in. by 1.20 in. in size. The sewage covers and passes through the lower part of the screen, and as it rotates it is kept clean by brushes which remove the screenings to a receptacle or conveyor.

Nearly all the visible solids and from 15 to 30 per cent. of the total suspended solids may be removed by fine screening, so that the effluent is not only less objectionable in appear-

ance, but is in a much more favorable condition for oxidation by the stream to which it is discharged or by any process of filtration.

2. To Avoid the Formation of Sludge Deposits, with Their Resulting Odors and the Necessity of Dredging

This is accomplished by settling, first in grit chambers, to remove the sand and heavier solids, and then in tanks, to remove the finer solids. The theory of rational tank design is admirably described in *Annales des Ponts et Chausses* for January-February, 1917, by H. Verriere, supported by the results of the Mont Mesly Experiment Station at Paris. Verriere concludes that horizontal tanks, with a length of from 4 to 12 times the width, should have a sump at the influent end and then a depth of from 5 to 10 ft., sloping upward to about 3 ft. less at the farther end. Such tanks will care for about 200 gals. per day for each cubic foot of volume.

Septic tanks, in which the sludge is digested, should be about twice as deep, or 20 ft. instead of 10 ft., near the influent, to provide storage for the sludge. These are more costly to build, but, as there is less sludge to handle, they are less expensive to operate. Operation is not, however, always satisfactory, as there is greater probability of odor than with fresh sludge.

Vertical, or, as we usually call them, "Dortmund," tanks occupy but one-third, or at most two-thirds, the space required for horizontal tanks, but are more costly, due to their depth. Seven and one-half feet is found a sufficient distance for the sewage to flow upward in the tank at a rate of about .05 or 0.1 ft. per minute, though rates from two to four times these are frequently used. Sludge storage should be provided in the pyramidal or "hopper" bottom for five days' accumulation. Tanks of this description will treat 65 to 130 gals. daily for each cubic foot capacity, including the hopper.

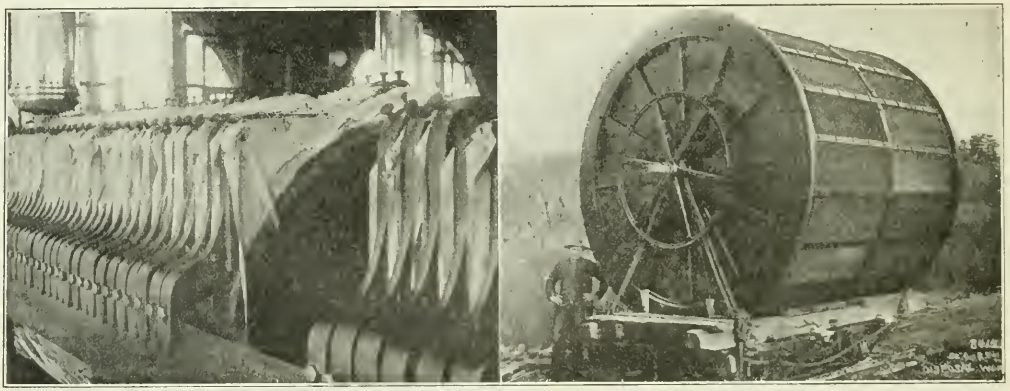
The Imhoff tank is merely a modified form of a septic tank, but with a separate chamber for the sludge, capable of storing it for from four to eight months. It is, therefore, yet more costly, but provides greater security from odor than either the septic or Dortmund tank.

Now either of these types of tank will remove at least 40 to 60 per cent. of the total solids with good operation, and if higher efficiencies are required chemical precipitants may be employed, usually with the horizontal type of tank. By this means a removal of 70 to 80 per cent. is practicable, and the effluent is free from turbidity, though often colored.

Unless some of the solids in solution are thrown down by the salts contained in the body of water to which it is discharged, the danger of sludge deposits is avoided, but if the supply of oxygen in the stream is sufficient, there remains the danger of subsequent putrefaction, with its evolution of foul gases.

3. To Avoid the Production of Odors in the Stream Receiving the Effluent

Contrary to common opinion, fresh sewage has no strong or particularly disagreeable odor if dissociated from the idea of its origin. But when it becomes septic—that is, when it has used up the available supply of oxygen which it contains—it turns black with the production of foul gases. In other words, oxidation gives way to putrefaction, and these conditions result in odors due largely to sulphureted hydrogen and other more complex compounds of sulphur. The obvious remedy is to maintain a supply of oxygen, so that decomposition may take place on an aerobic instead of an anaerobic basis, and this is accomplished either by dilution with a sufficient volume of water already supplied with dissolved oxygen or by some method of filtration whereby oxidation is promoted. In either case the actual change, mainly brought about through the agency of nitrifying bacteria—that is, bacteria which oxidize the ammonia compounds in the sewage to the more stable form of nitrates. In this form the nitrogen is available for plant food and the oxygen is available as a reserve that may be drawn on for the oxidation of organic matter.



LEFT: SLUDGE PRESSES, WORCESTER, MASS., SEWAGE TREATMENT WORKS. RIGHT: VIEW OF WEAND SEWAGE SCREEN AT BALTIMORE, MD., BEFORE ERECTION.

Irrigation and sand filtration are common modes of oxidizing liquid wastes, but the typical process now employed in sewage disposal practice is by trickling filters.

Trickling filters, which are usually composed of a bed of broken stone 1 in. to 2½ in. in size and 7 or 8 ft. deep, permit the gradual percolation of sewage over the surfaces of the stones in such a way that it is rapidly oxidized by the gelatinous bacterial film which forms on them after a few weeks' use, becoming in this way stable—that is, free from the tendency to putrefy and give off bad odors.

4. To Prevent Dissemination of Disease

Sewage necessarily contains the germs of typhoid, tuberculosis and many other diseases, and where the effluent is liable to find its way to sources of water supply or to beds on which shell fish are cultivated, it is desirable to eliminate these germs, for even the more thorough processes of oxidation furnish no guaranty of their absence.

The standard method of disinfection or an approach to absolute sterilization is in dosing the effluent, after freeing it from the larger particles of suspended matter by screens or tanks, with from 3 to 10 parts per million of liquid chlorine and allowing them to remain in contact for an hour or so. The effluent is this way freed from 96, 97 or perhaps more

than 99 per cent. of the contained bacteria, including those which produce disease.

Complete treatment, according to the standard American practice of today, comprises, therefore:

Sedimentation in tanks with or without fine screening;

Oxidation by trickling filters;

Disinfection with chlorine.

Recent and Future Development

Recent development in sewage treatment has been, if we disregard the question of sludge handling, rather along the lines of improvement of well-established procedure than in radical innovation.

Fine Screening

The recommendation of fine screening for certain situations by engineers of standing, combined with the placing of the Riensch-Wurl screen on the market by an American manufacturer, has given a certain impetus to this method of treatment. Much information is yet lacking regarding the cost and efficiency of these machines with American sewages and operation, but from now on this should be increasingly available. On the whole it seems probable that fine screening will be adopted more and more by our seaboard and lake cities and those located on large rivers, in order to satisfy aesthetic demands.

Notable examples are the cities of Cleveland, where fine screens are to be employed at the new West Fifty-eighth street plant, probably Indianapolis, and New York, where, in addition to the Dyckman street and Twenty-sixth Ward plants, they are proposed at West Forty-sixth and East Forty-first streets, Manhattan, and at Theodore street and for the Rockaways, in Queens.

Settling Tanks

In the design of settling tanks progress appears to be more in the nature of refinements in proportions, baffling and the method of receiving and discharging the sewage and drawing the sludge. As an example may be mentioned a tank of three separate chambers designed by J. W. Alvord for the Great Lakes Naval Training Station. The essential features comprised are hopper bottoms for the withdrawal by gravity of sludge from the two outer tanks to the middle or sludge tank and from the latter for disposal; the withdrawal of effluent from one outer tank to the other and from the latter for disposal, from the stratum of optimum clarification lying below the scum. It also involves the withdrawal of the scum itself from the outer tank receiving the raw sewage and its delivery to the sludge tank. The effluent is claimed to be of exceptional clarity.

The tendency for several years has been to limit the period of retention to that required to remove a reasonable proportion of the settleable solids—say 80 or 90 per cent.—rather than to attempt an unreasonable—that is, uneconomical—efficiency regarding the total suspended matter.

As to the tanks, although the septic tank is the type most commonly found in this country, it is being gradually supplanted by the two-story Imhoff tank in new installations. This perhaps is due chiefly to the ineradicable defect in the quality of the effluent, which is ill-smelling and turbid. Nevertheless, some of the better examples are giving satisfaction, and now, on account of their simple construction and low cost, and in order to avoid the objection attending scum formation, to be anticipated with fresh domestic sewage in Imhoff tanks, they have been adopted as the standard for our army cantonments.

Chemical Precipitation

Chemical precipitation with lime, alum or copperas shows no indication of a revival, although in certain situations, especially in connection with industrial wastes, it will probably continue to be found advantageous. A strong point in its favor lies in its effective removal of the readily decomposable colloids. Excellent examples remain at Worcester and Providence, but the four antiquated plants in Brooklyn and Queens have outlived their usefulness and should be turned to better use or abandoned.

But precipitation involving the use of sulphuric acid (or perhaps sulphur dioxide) to concentrate and separate the solids and grease, as employed at Bradford and Oldham, England, and as patented here as the Miles process, has some distinct advantages, and may on further investigation prove worthy of serious consideration as a means of recovering grease and fertilizer. The process is said to be inodorous and the effluent nearly sterile.

Tank Design

In tank design it is believed the vertical type will grow in favor where the depth does not make the cost too great, for the efficiency of such tanks is high, and they lend themselves more readily to the automatic removal of sludge without interruption to the process of sedimentation .

If the sludge is to be digested, the Imhoff tank appears to satisfy most conditions. Experience tends to favor a more

GENERAL VIEW OF LONDON CHEMICAL PRECIPITATION WORKS AT BARKING.

Workshop (Gable in front), Main Engine House (in rear), and Boiler Houses (on flanks).

liberal capacity of the sludge chamber, horizontal rather than radial flowing through chambers, greater attention to the suppression and removal of scum where this is troublesome, and the prevention of the accumulation of the products of septic decomposition in sludge pockets by a movement of their contents by drawing off sludge, by the introduction of a small amount of water or sewage through a jet or by mechanical stirring.

Separate Sludge Digestion

Experiments with separate digestion chambers have been made at different times and places. At Birmingham, England, and Baltimore the fresh sludge has been stored in open tanks, apparently without objectionable results, but it is probable that a safer plan is to prevent exposure to the air and promote intensive septic decomposition. This was being tried out at Elberfeld, Germany, when visited five years ago, and has been experimented with at the Twenty-sixth Ward plant in Brooklyn and elsewhere, with, it is believed, satisfactory results; but no general conclusions appear to have been arrived at as to the merits of this practice. In some situations the cost of installing deep tanks would be greatly reduced.

Pumping Sludge to Central Plant

A further step has been suggested as an economy in the handling of sludge from a series of plants in pumping to some central point for storage, and, possibly, drying and the recovery of by-products. The pumping of sludge for distances of four or five miles is successfully carried out at Birmingham, Bradford and Glasgow, and where the expense of constructing and operating independent sludge treatment plants, and especially if the construction of a costly intercepting

sewer, can be avoided, the plan of establishing a central sludge plant has much in its favor.

Activated Sludge Process

Among oxidizing processes the activated sludge process has received the greatest amount of attention for the past two or three years. Owing to the war, development in England, where it was first put in practice, has been hampered, but to the several plants already in operation there is to be added one at Manchester. In this country, although at least seven plants have been installed, there is a great deal to be done in the way of standardizing methods. Valuable data have been secured at Milwaukee by Hatton and Copeland, at Urbana by Bartow, and in the sanitary district of Chicago by Pearse, resulting in progressive improvements. For instance, the removal of the coarser particles by grit chambers and sometimes by fine screens before activation has been shown to reduce the volume of air required. But tank details, type of diffuser, optimum air volumes and pressures and periods of detention are matters yet to be standardized for general practice, and will always vary with local conditions. As a test of the effluent the determination of the albuminoid ammonia has been found most indicative at Pasadena. If less than 2 p.p.m., the effluent is said to have a stability over 99.

On the whole, it would appear that the advantages of the activated sludge process lie in the small space required—one-third or one-fourth that for a trickling filter plant—and in the recovery of fertilizer in the sludge. But as the question of space is often of little importance, as the plant is expensive and the operation one requiring a high degree of intelligence and skill, and, further, as the value of the by-products depends upon the quality of the sewage, it may as well be conceded that the outlook for its adoption by small towns is not bright and that no city should undertake to install the system without thorough preliminary investigation and expert advice.

The handling and disposal of sludge always co-exist with tank treatment. Activated sludge has been found so offensive when left to dry out in the air that some form of de-watering is obligatory. Preliminary concentration by a Dorr thickener has been used at Milwaukee, and this brings up the possible advantage in removing sludge in plain sedimentation plants from the bottom of large shallow tanks by rotary scrapers or some other device, especially where the cost of rock excavation for deep tanks is high. The relative advantage of further de-watering to 75 per cent. moisture Berrigan, Kelly and Sweetland presses, instead of the usual plate filter press, have been partially tried out, and it is hoped that more definite conclusions than are now available may be arrived at within the next year or two.

The Miles Process

Aside from the activated sludge process, the Miles process, already mentioned, has attracted more attention than any other in relation to the recovery of by-products. By the use of sulphur dioxide, which may be obtained from niter cake, the grease, including that from soaps, separates out with the sludge, and, after recovering this by percolation, the degreased sludge has a certain value as fertilizer base. Experiments have indicated a material net revenue possible from the Boston sewage collected at Moon Island of from $200,000 to $400,000 per annum, based upon a flow of 100 m.g.d. and pre-war prices for grease. Under present conditions the revenue from grease would be four times and that from fertilizer over 2½ times the corresponding figures before the war. Efforts have been made to provide for a trial of the process on a large scale, but as yet without success. So much has been expected and so little accomplished in a commercial way from sludge that much conservative opposition must be overcome, but as time passes the prospect of a moderate success in this line, where conditions are favorable, seems to improve.

It may be of interest to mention that at Wolverhampton, England, wet activated sludge has been successfully used as a fertilizer by irrigation.

With the treatment of tank effluents nothing notable is to be recorded in the recent past except the possibility of rapid mechanical filtration with a high-grade tank effluent, as is being used by Mr. Alvord at the Great Lakes Naval Training Station, already referred to. The results will be looked for with interest.

Disinfection with chlorine has become well established as a prophylactic measure in connection with water supplies, and to a less extent with sewage effluents.

A new disinfectant, known as "chloramid" (NH_2Cl), is said to offer an economical advantage in its selective action on bacteria, chlorine being partially used up on the other organic matter in the sewage.

Summary

To sum up, progress in sewage disposal during the past year has been rather in the development of established processes and a refinement of design rather than in any marked innovation.

In particular there has been a moderate increase in the use of fine screening, which promises to continue, and the septic tank has enjoyed a certain revival in its use for army can-

VIEW OF RIENSCH WURL SEWAGE SCREEN IN OPERATION AT DRESDEN.

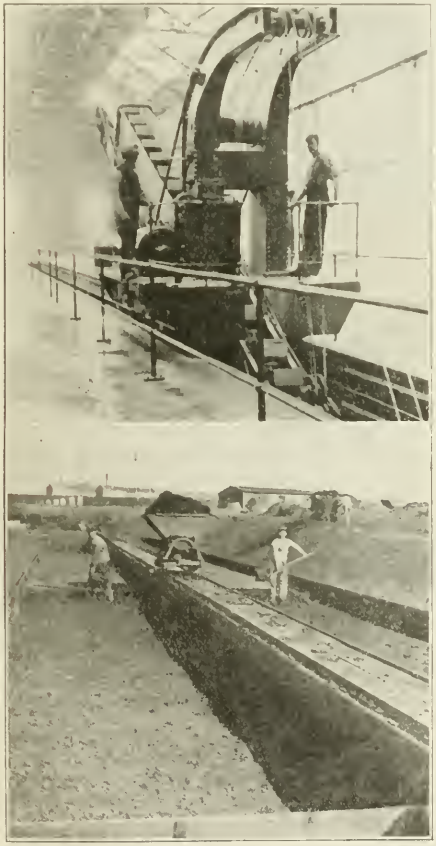
tonments. A large addition has been made to our information regarding the activated sludge process, but there are several important details which remain in the experimental stage, and until these are determined there will remain some question as to the applicability of this treatment.

Progress in sludge treatment has perhaps been of more importance than that of sewage alone. Before the war the price of fertilizers had risen, owing in part to the natural increase in demand and in part to the decrease in the output of manure following the introduction of motor vehicles. The theoretical loss of nitrogen has long been recognized. According to Sir William Crookes, the United Kingdom disposed of this in the sea to the extent of $78,000,000 per annum. And in addition there is the grease, which, in many sewages, outweighs the nitrogen in value. Now, owing to the war, the demand for both of these has increased and is increasing enormously. Greater attention has been directed to their conservation by garbage reduction than before, and now the activated sludge and the Miles processes are two possible methods available for utilizing sewage sludge with apparent profit. Both of these have received increased attention during the past year, and, especially in methods of concentration and drying, definite progress is anticipated in the near future.

Owing to the unstabilizing effect of the war on values, questions of sewage disposal are subject to a searching realignment. Sewages near munition works have changed in character and amount; labor is more difficult to secure; en-

gineers and chemists have been largely diverted to other fields of employment; prices of metals and chemicals have soared upward, and attention, for the time, is directed to other more important ends. Nevertheless, for the comfort as well as the general sanitary well-being of the community, sewage disposal problems should not be neglected, but should rather be studied and solved with even greater regard to efficiency than ever.

Finally, there has been a marked movement for several years past toward a more rational attitude regarding the goal to be aimed at in sewage treatment. Former rigid and often unreasonable requirements as to effluents, regardless of the conditions attending their discharge, are giving way to a



UPPER: INTERIOR VIEW OF GRIT CHAMBER, GLASGOW, SCOTLAND, SEWAGE WORKS. LOWER: REMOVING SLUDGE FROM DRYING BEDS, ESSEN, SEWAGE WORKS.

search for the best way to attain the degree of purification required by the particular case in hand. Careful studies of mimimum stream flow, the dissolved oxygen available in the water and the rapid diffusion of the effluent, as well as the character of the sewage as to settleable solids, organic matters in the colloidal as well as the solid form and in solution, amount of fats, age and oxygen demand, are all recognized as of importance in deciding on the mode of treatment. And having in view the object sought—whether to prevent deposits, or odors, the destruction of fish life, or merely to preserve a decent appearance in the stream—the means to realize the end should be the one that will be found not only the most economical, but the one most generally acceptable from every point of view to those living near the plant, to the riparian owner and to the taxpayer.

Some Results Secured by Chlorine Compounds in Water Purification and Sewage Treatment

By C. A. Jennings, Sanitary Engineer, People's Gas Bldg., Chicago, Ill.

Less than ten years ago, hypochlorite of lime was used for the first time on a large scale for the disinfection of a water supply. Previous to this it had been used in large quantities to prevent the spread of typhoid fever from polluted water supplies, but no attempt had been made so to treat a polluted water that disease producing organisms would be eliminated and yet the water would remain unchanged in taste and odor. In these ten years, the uses of chlorine compounds in sanitary science has grown tremendously. As would be expected, because of such a rapid growth, the use of these substances has come into bad repute in some instances. Sometimes this has been due to the fact that over-zealous people expected more of the treatment than could be accomplished and sometimes it has been because water companies or departments attempted to accomplish with chlorine compounds work which called for clarification in conjunction with disinfection. Things have adjusted themselves very satisfactorily by this time and filtration has its place, decolorization its place, iron removal its place, chlorination its place and so on. Some problems require for solution a combination of several methods of purification, said Mr. Jennings, in addressing the Southwestern Water Works Association.

Used as Finishing Treatment

It was in 1908 that the epoch-making work was done at the Bubbly Creek filtration plant at the Chicago Union Stock Yards by Mr. Geo. A. Johnson, using hypochlorite of lime to make potable a grossly polluted water in conjunction with a rapid sand filtration plant. Previous to this it had been considered sufficient to remove 97% of the bacteria by purification processes. Since that time however, filtration plants in nearly every instance, use chlorine compounds as a finishing treatment. By the process of filtration, bacteria are removed mechanically. An average of 97% to 98% of the total bacteria can be removed by this process. Chlorine compounds are used as a finishing treatment because they seemingly have a selective action for the organisms that cause disease. The quantities required are very small. Every new filtration plant that is modern, will be found to be equipped with a liquid chlorine apparatus for sterilizing the filtered water. Examples of this are: Kansas City and Emporia, Kan., Tulsa and Guthrie, Okla., Fort Worth and Dallas, Tex., Cleveland and Cincinnati, Ohio, Baltimore, Md., Louisville, Ky., and Indianapolis, Ind.

Reasons for Popularity of Chlorine in Liquid Form

Whereas hypochlorite of lime was formerly used entirely for the disinfection of water and sewage, now it has been almost entirely replaced by liquid chlorine treatment. The reasons for this are many, viz: Hypochlorite of lime or "hypo," is a loose compound of lime and chlorine gas, in other words, the lime serving as a carrier for the chlorine gas. Moisture and carbonic acid in the air, cause this loose compound to deteriorate by giving off chlorine. Shipment is made in wood and sheet iron drums, which are likely to disintegrate. The strength of the hypo decreases rapidly upon exposure to the air. There is considerable loss to the material by being weighed out and being made up into a solution and there is a great deal of undesirable nuisance connected with this operation. Accurate readings must be made of the amount of solution being applied. Orifices and solution feed lines clog up with undissolved material in the solution.

Chlorine Compounds Compared

Liquid chlorine or compressed chlorine gas, is shipped in steel cylinders holding 100 and 150 lbs. each. These are similar in appearance and construction to ammonia, oxygen, and carbonic acid cylinders. At room temperature the pressure on a full cylinder of chlorine is about 90 lbs. Being under pressure, there is no loss in the strength of the substance. In order to liquify the gas, it is necessary to rid it of its impurities and so it will average over 99.8% pure chlorine as used from the cylinders. In the use of liquid chlorine for the disinfection of water and sewage it has been found that the ratio between the amount of hypo to the amount of chlorine to accomplish similar results is about 6:1, with a minimum of 3:1 and a maximum of 10:1. These ratios depend upon the strength of the hypochlorite in the solid form, upon the care with which a solution is made of the hypo in the water and upon the care with which the solution is applied to the water. The ease of operation, especially the direct reading of the amount of sterilizing agent being used, lends itself to more accurate control and more consistent results than could be obtained by the use of hypochlorite. Tastes and odors are seldom met with in supplies treated with liquid chlorine. Milwaukee, Wis., effected a saving of $2,200 in one year on labor alone by the use of liquid chlorine instead of hypochlorite. An appreciable saving was effected also in the chemicals used in favor of liquid chlorine. Minneapolis, Minn., saved $1,800 the first year of operation with liquid chlorine instead of hypochlorite, all of which saving was in the cost of the chemicals. In addition to this there was a saving in labor. The average cost of disinfection with liquid chlorine during 1917 was 37 cts. per million gals. In more than two years, there have been no complaints of tastes and odors resulting from this treatment. At the present time there are probably 1,200 cities in this country using chlorine compounds for the disinfection of water and sewage. Of these, possibly 300 are still using hypo and the others are using liquid chlorine.

Little Prejudice Against Chlorination Now

The former prejudice against "doping the water supply" with a "foul-smelling chemical," has almost died out. This has come about through the successful treatment of water supplies, in most instances, without any production of odors or tastes, through the wonderful reduction in the typhoid fever death rate and through the winning over of the health officers and other members of the medical profession to an understanding of what this treatment could and would accomplish.

There was a time not so long ago, when as a result of a report submitted by a committee composed mostly of Washing members of the medical profession, Congress decreed that no coagulating or other chemicals could be used in the purification of the water supply of Washington, D. C. Today, the water supplies of most of the government cantonments, construction camps, ship building yards, etc., are treated with liquid chlorine in addition to the fact that the soldiers and sailors are all vaccinated against typhoid fever and in most of the camps, the water is obtained from underground sources. Practically half of the state boards of health of this country are supplied with a portable emergency chlorine control apparatus weighing 40 lbs., mounted in a carrying case which is shipped out to municipalities in the event of a sudden typhoid fever epidemic or scare. Such measures make for expedition, increase the confidence of cities in the aims and assistance of state health departments and help lower the typhoid fever death rates of cities by giving prompt and efficient control of emergency conditions.

Disinfection of Water Supplies

Liquid chlorine is used in the disinfection of all types of water supplies, viz: Water obtained from rivers, lakes, impounded supplies, shallow and deep wells, filter galleries, filtration systems, etc. Mountain streams, impounded supplies and well waters are no longer considered safe because they are obtained from the mountains, storage reservoirs and the ground. There are too many contaminating influences to be considered. The Chicago Bureau of Public Efficiency in its report on the Water Works of Chicago, states that "a water supply contaminated on four or five days in a year, may result in serious epidemics." Many cities have learned that liquid chlorine is a safe, cheap and reliable form of health insurance. The manager or superintendent of a water plant, who uses liquid chlorine treatment, does not have to lie awake at night fearful of the quality of his water supply.

The city of South Bend, Ind., obtains its water from deep wells. The U. S. Public Health Service analyzed the water during the summer of 1917 and found B. Coli present. Disinfection was ordered to be installed at once. This was done. It was found that the water coming from the wells was pure. The water being pumped from the storage reservoir was polluted. The chlorine was applied to the suction of the high duty pumps—beyond the last possible point of contamination. Then steps were taken to remedy the condition causing the contamination to the reservoir.

A small city in Michigan derived its supply from wells. The State Board of Health discovered a cross-connection with a pipe leading from the river. Chlorination was ordered to be installed at such a point that whether the cross connection was open or not, all of the water would be treated with liquid chlorine.

Chlorination of Well Waters

Many cities having supplies from underground sources have conditions similar to those at South Bend and frequently have epidemics of intestinal disorders in their cities. Because a water comes from a deep well is no criterion of its purity as it is supplied to the consumer if proper precautions are not taken to prevent its contamination. Frequent analyses of all water supplies should be made. Given the proper conditions, a spring, deep well, or other originally pure water can and will become contaminated as quickly as a surface water.

Liquid chlorine is now being used in many of the government hospital camps in this country and abroad, for the preparation of the Carrel-Dakin solution, which is used in the treatment of wounds.

A recent use for liquid chlorine has come to the notice of the writer. An Illinois city having a deep well supply that has an iron content of 2 parts per million, aerates and filters the water to remove the iron. Recently considerable difficulty has been experienced due to the growth of crenothrix in the storage reservoir and distributing mains. Liquid chlorine is being used for killing this organism because copper sulphate treatment has been unsuccessful.

Chlorination of Trade Wastes

Tanneries discharge liquid wastes carrying the Anthrax organism. This germ is what is known as a spore former and it is very difficult to kill it. The U. S. Bureau of Animal Industry has recently issued regulations governing the treatment of these wastes with liquid chlorine.

Packing houses discharge liquid wastes that have very disagreeable odors. Recent experiments on a large scale in a packing house indicate that it is possible so to treat these wastes with liquid chlorine that the odors will be rendered practically unnoticeable.

By means of liquid chlorine treatment many other kinds of trade wastes can be successfully disinfected and the odor reduced to a point where no nuisance will be committed.

Sanitation of Swimming Pools

Little thought has been given by the layman to the gross contamination that results from the use of the average swimming pool. The shower bath that is made a preliminary to the swim at most pools is usually a sham and does little good. A pool is certain to become highly polluted as a result of bathers using it. The modern method of keeping a swimming pool in a sanitary condition is to pump from the pool water at a

rate sufficient to empty the pool in 18 to 24 hours. This water is forced through a pressure filter to clarify it and then it is sterilized with liquid chlorine and returned to the pool. In this manner a definite amount of polluted water is withdrawn from the pool and the same quantity of pure water returned to the pool continuously. No heating of the water is necessary in this purification process as the water remains at the temperature of the pool.

Liquid Chlorine in Sewage Treatment

Liquid chlorine is used as an adjunct to various methods of sewage treatment. The City of Cleveland, Ohio is to install fine screens to clarify the city sewage and these screens will be followed by liquid chlorine disinfection. At many of the government camps, the sewage is sterilized by liquid chlorine following treatment by septic tanks, filters and other systems. The amount of chlorine required is much greater than in the case of water purification and varies from 40 to 90 lbs. per million gals. depending upon the character of the sewage and the degree of purification desired.

Specific Examples of Successful Chlorination of Water Supplies

As an example of what can be accomplished by chlorination of the water supply, the case of the City of Chicago offers excellent proof. Previous to 1900, all of the sewage of the city found its way into Lake Michigan, from which the water supply is taken. In 1900 the Chicago Drainage Canal was opened, which served as a method of disposing of the greater portion of the sewage. The Chicago River, formerly flowing into the lake, was reversed and was made to flow in the opposite direction, carrying with it the city sewage and a definite quantity of lake water for dilution purposes. As time went on, more and more sewage was diverted from the lake and control was exercised over the dumping of dredgings in the lake, discharge of lake boat toilets in the vicinity of the water intake cribs and other similar sanitary measures. The curve showing the typhoid fever death rate of Chicago is remarkable because it shows what the above mentioned measures accomplished and it demonstrates what partial and what entire disinfection of the water supply will accomplish. Chlorine disinfection was in use at some of the pumping stations during the period 1911-1916, but during 1917 all of the water pumped by the nine stations was chlorinated. The drop in the typhoid fever death rate from 5.2 to 1.7 is wonderful. During 1917 only one sample of water out of 1,779 samples collected for analysis or .06%, showed the presence of B. Coli in 1 cc. B. Coli was present in 5.4% of the 10 cc. portions tested. In 1916 there were 135 deaths from typhoid fever and 1917 only 43.

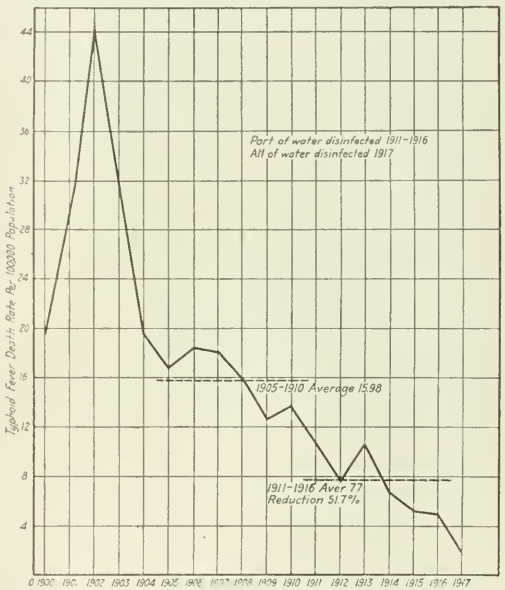
Baltimore's water supply is derived from lakes. Previous to the use of chlorination, the average typhoid fever death rate for the period 1907-1910 inclusive, was 35.38. Hypochlorite treatment was begun in June, 1911. For the years 1912-1915 inclusive, the rate was 23.13, or a reduction of 34.6%. In September, 1915, a filtration plant was put into service and a further drop resulted in the typhoid fever death rate. Liquid chlorine was substituted in 1916 for hypochlorite of lime.

Jersey City was one of the first cities to adopt chlorination of the water supply, beginning the treatment in September, 1908. The average rate for the years 1900-1907 inclusive, was 18.7. For the period 1909-1917 inclusive, the average rate was only 7.3, or a reduction of 60%—truly a remarkable showing for water disinfection. The change from hypochlorite to liquid chlorine was made in February, 1913.

Hypochlorite treatment in Detroit was begun in March, 1913, and the change to liquid chlorine was made three years later, March, 1916. The average rate before chlorination was 19.25 and after chlorination 15.05 per 100,000, a reduction of 21.8%.

Waukegan, Illinois, is one of the many cities drawing its water supply from the Great Lakes which were forced to install water disinfection because of the large amount of typhoid fever. The treatment was begun in April, 1912. Data are available only for the period from 1911 to the present time. Wonderful results were obtained. In 1911 there were 14 deaths from typhoid fever and in 1912 there were 20. The next year there were only two deaths, then for two years there were no deaths, and then three and six respectively, for the two following years. In other words for the entire period of five years since water disinfection was begun there have been only eleven deaths from typhoid fever. The water supply at Waukegan should be filtered because it usually carries considerable organic matter and turbidity.

The Milwaukee records show an appreciable reduction in the typhoid rate after chlorination was practiced regularly. Hypochlorite was used June 21 to Dec. 12, 1910, not at all during 1911, Feb. 2 to March 18, 1912, and then continuously after April 12, 1912, until May, 1915, when liquid chlorine was substituted for hypochlorite, and this has been used continuously since that time. The average for the five year period while



CURVE SHOWING EFFECT OF DISINFECTION OF CHICAGO PUBLIC WATER SUPPLY ON TYPHOID FEVER DEATH RATE.

disinfection was not in use, 1906, 1907, 1908, 1909 and 1911, was 21.8. For the period 1913-1917 inclusive, the rate dropped to an average of 8.9, or a reduction of 59%.

The water supply of Omaha is obtained from the Missouri river, which name is almost synonymous with "mud" and is coagulated and settled in large basins. In 1910 hypochlorite treatment was installed. For the period 1906-1909 inclusive, the typhoid fever rate was 99 per 100,000. For the period 1911-1917 inclusive, the rate was 25.4, a reduction of 74.3%, which is truly a remarkable accomplishment. The change to liquid chlorine was made in 1915. The death rate has steadily and consistently dropped since 1910 and for both 1916 and 1917 was below 5 per 100,000.

There is no doubt but that the use of liquid chlorine will continue to grow. The only danger is from over-zealous sanitarians recommending its application in cases where it is not called for or in cases where it should be used in conjunction with some other process. As with all purifying agents, it has its limitations. Within its sphere of usage, it has demonstrated its reliability and simplicity and its efficiency is proven by typhoid fever statistics.

From Workers in Field and Office

Anonymous Communications

For many years newspapers have carried at their mastheads statements that they pay no attention to anonymous communications. Despite this practice, unsigned letters are occasionally received, intended for publication. Thus a letter was received by the editor, signed, "Disinterested Party and Not a Contractor." That nom de plume would serve well enough, but the identity of the writer should be made known to the editor. There is no objection to the use of an assumed name for publication, but the correspondent's real name should be confided to the editor. If an editor publishes a purely anonymous letter, he must assume the responsibility for it, and must either defend it or make a public disavowal of its import. Editors are busy most of the time defending their own actions, and cannot undertake to assume the responsibility for literary children whose parents disown their offspring.

Using Compressed Air Equipment on Street Repairs

Editor Municipal Engineering:

Sir—We are using the Domestic compressed air equipment for street repairs. It requires but one man to operate this machine and the results have always been satisfactory in every way.

We can clean six brick with this machine to one by hand. When cleaning by hand many of the brick break, while with the machine we seldom ever have any breakage.

We have also used this equipment out in the field for riveting boilers, etc., and have found it very convenient, in fact, would not be without it.

Very truly yours,

The Enterprise Paving & Construction Co.,

Cleveland, Ohio. James H. Rose, Pres.

The Cost of Drilling Blast Holes

Editor Municipal Engineering:

Sir—The cost of drilling blast holes depends altogether upon the kind of rock, wages paid, the kind of machine used, the energy of the driller, the carelessness of the driller in keeping his machine in repair and making large repair bills when unnecessary, and a thousand and one other things which enter into the subject.

In some places it is with the greatest difficulty that more than 3 or 4 ft. can be drilled in a day of 10 hours, and in other places a good driller can drill more than 100 ft. per day of 5⅝-in. diameter holes. The kind of fuel used also enters into the subject, also the cost of same.

We doubt if any two quarries can show the same detail of costs. Some quarries have been obliged to suspend operations because of the enormous cost and the difficulty of sinking the blast holes. Very truly

The Loomis Machine Co.,

Tiffin, Ohio. Geo. D. Loomis, Pres.

Ohio Highway Department Employs Compressed Air Equipment in Repair of Brick and Concrete Roads

Editor Municipal Engineering:

Sir—The compressed-air equipment which we used in the repair of brick and concrete roads was a Schramm (Philadelphia) outfit. The outfit consists of the compressed-air equipment operated by a small gasoline engine. This operates very much on the principle of a compressed rivet outfit and substitutes a chisel for the hammer. We carry twelve to eighteen chisels of different designs, in order to be able to select a chisel which is suitable for the specific class of work the outfit is doing. The outfit is used in trimming up the edges of an area to be patched or rebuilt in brick (cement filler) and concrete roads. The outfit works very satisfactorily in cutting vertical edges, and also, in the case of brick roads, in toothing out the edge in order to secure a suitable bond of the new brick patch with the old surface.

We cannot give any figures showing the exact results between the cost of work done this way and work done by hand, but we are quite positive that the work done by the outfit is accomplished much cheaper than it could be accomplished by hand methods; in fact, it would be almost impossible to accomplish the same grade of work by hand methods as by the use of this outfit. Very truly yours,

Clinton Cowen,

Columbus, Ohio. State Highway Commissioner.

The Bankhead National Highway

Editor Municipal Engineering:

Sir—*The Literary Digest* of May 4 contains an article from Municipal Engineering headed, "Speed Up the Roads!" I wish to commend said article as wise and most opportune. The delay of the state highway commissions in not responding to the request of Secretaries McAdoo and Houston is regrettable. The people of this country have not fully realized the full importance and necessity for good roads. The time will come, if this war continues, when good roads will be as essential in winning the war as the sale of Liberty Bonds today.

Here is proof of the great interest and enthusiasm displayed by the people of the South in road building. Eighteen months ago a small party of road enthusiasts met in Birmingham, Ala., with a view of linking together the roads between Atlanta, Ga., and Memphis, Tenn. At this meeting an organization was formed and the name adopted was the Bankhead National Highway Association. Pathfinders were appointed, who made a careful survey of the different roads and reported their findings to the board of directors. The demand from the people from Atlanta to Washington to be admitted into the organization was so great that a pathfinders' committee was appointed to make the survey. The road has practically been located east to Washington.

The western end of the road towards the Pacific ocean is being taken care of, as was shown by the large number of delegates, 1,780, that were present at the annual meeting of the organization held at Little Rock, Ark., on the 18th and 19th of April. Pathfinders will be appointed at once to make an examination of the road from Memphis to El Paso. This great transcontinental road will traverse the loveliest country in the world; can be traveled every day in the year, without regard to any special season. In some of the country through which it passes in the South the roads are never covered with ice and snow, but are bordered with green vegetation and beautiful flowers throughout the entire year.

This road will pass 17 cantonments. It runs from ocean to ocean, paralleling the great Lincoln Highway across the entire country. It is our hope to have the government take over these two lines of road as military and post roads.

Some of the results of the good road spirit along this route are already shown. Every stream from Memphis to Washington through which the road passes has been bridged, and some of them by individuals, at great cost. Two instances came under my personal observation where the grade of the road was above 20 per cent., and by great engineering these stretches have been reduced to 5 per cent.

Millions of dollars have been raised by the sale of county bonds throughout the entire length of this route, and land values have been increased largely by its proposed construction. So we have formulated a working plan, if the government will assist in its execution.

Very truly yours,

T. S. PLOWMAN, President,

Talladega, Ala. Bankhead National Highway Assn., Inc.

Making Tight Joints in Vitrified Clay Sewer Lines

Editor MUNICIPAL ENGINEERING:

Sir—Better joints for vitrified clay pipe are now being made by pouring the joint material than is possible by the old hand-troweling method. Proof of this fact, together with the development of more satisfactory equipment for the pouring method, makes it advisable that all vitrified pipe lines, where tightness is requisite, should be installed with poured joints.

The permanence of vitrified clay pipe, due to its resistance to chemical and electrolytic attack, coupled with its high tensile strength, has inspired a vast amount of search for joining methods that would be worthy of the pipe. The answer is the poured joint.

Joint Materials

Either cement grout or bituminous joint materials may be used with entire satisfaction for the construction of poured joints. The choice must depend upon conditions. The bituminous materials (such as G. K. compound, made by the Atlas Company, or Filtite, made by the Pacific Flush Tank Company) provide a quick setting joint that permits backfilling within a few minutes after the material is applied, while cement takes 24 hours or more to set. The bituminous joint has a certain amount of elasticity and is better for that reason wherever pipe is laid over refilled earth or wherever the pipe line is subjected to strains that tend to break it.

Poured vs. Troweled Joints

In comparing the two forms of cement joint, the poured and the troweled, the former will be found to have the following advantages:

1. Greater certainty of filling the pipe bell with joint material. 2. A denser cement when set. 3. More rapid operation. 4. Saving in joint material. 5. Less need for working space in trench. 6. A neater and more workmanlike job. 7. A cleaner operation from the workman's standpoint. Of these advantages, Nos. 1 and 2 relate to the efficiency of the joint and Nos. 3, 4 and 5 to its economy. Nos. 6 and 7 may be regarded as sentimental advantages, but they are not so. Vitrified pipe installations have suffered in the past from inexpert efforts of laborers and helpers, who were assigned to the task partly because it was dirty work.

The Form or Runner

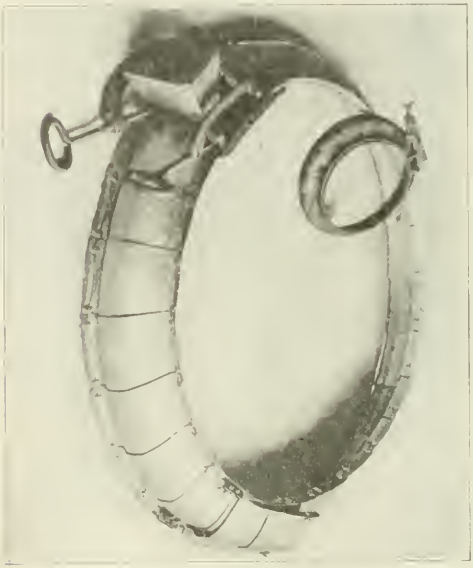
Pouring of joints necessitates a form to retain the fluid joint material. For pouring bituminous materials, heated to fluidity, it has been customary to use the familiar asbestos runner, sometimes called a "snake runner."

It has the shape of a section of asbestos rope, and is coupled around the spigot end of one pipe and pressed tightly against the bell of the pipe to be connected with it, after the bell has been caulked sufficiently to prevent the compound from entering the interior of the pipe line. Before pouring the heated compound, it is usually necessary to make a clay dam or funnel from excavated earth, surrounding the upper point of the joint where the compound is poured. The runner retains the compound in the bell. It may be removed in a few minutes, when the material has hardened.

The latest device for retaining fluid joint materials is the Flex-Form mold here illustrated, invented by the writer and manufactured by the Wyatt Engineering Company, of Columbus, Ohio.

The Flex-Form

The Flex-Form consists of a series of overlapping sheet



VIEWS OF 24-IN. ADJUSTABLE AND 6-IN. FLEX-FORM MOLDS FOR POURED JOINTS IN CLAY PIPE SEWERS.

metal plates or "scales" strung on two steel cables of small diameter and provided with a clamp and a funnel. The clamp is so adjusted that three different sizes of Flex-Form are a sufficient equipment for all of the different sizes of vitrified pipe from 3 in. to 24 in. The funnel divides in two parts when the forms are uncoupled for removal.

When clamped in position for use the Flex-Form holds the spigot end of one pipe centered in the bell of the pipe next to it and retains the grout that is poured in the funnel. During the period of setting it protects the bond of cement against any moderate shock or strain.

Making Grout Joints

The process of making grout joints with the Flex-Form mold may be briefly described as follows:

Mix equal parts of Portland cement and clean, sharp sand in their dry state. After thorough mixing, add water to produce a consistency of thick cream. Satisfactory grout cannot be secured if water is added before the dry ingredients are thoroughly mixed. One per cent. of water-proofing compound adds a factor of safety, but is usually not regarded as necessary.

After due precautions with regard to bedding and alignment of the pipe, insert spigot in bell as far as it will go and caulk lightly with oakum that has been dipped in the grout. Use just enough oakum to prevent the joint material from entering the interior of the line. More than this may weaken the joint.

Dip the Flex-Form in oil to prevent adherence of grout. Before applying, make certain that there is enough space beneath the bell in the trench to permit free passage of the Flex-

Form under and around the bell. Clamp the Flex-Form in place and make certain of an even grip all around the bell.

Pour a little water into the funnel to promote free flow of grout. Then stir and pour grout until funnel is full. There will be a slight leakage between the leaves of the Flex-Form, which is a safeguard against air pockets or accumulation of water.

Removing Forms—Testing

Forms should not be removed for 24 hours, when the trench may be backfilled, unless it is desired to test the line, as required generally by sanitary codes. In the latter case, the setting period should be 48 hours, after which the joint should be impervious under any prescribed water or smoke test.

Use of Compounds with Flex-Form

The Flex-Form mold is also well adapted to bituminous joints. It has two advantages over the asbestos runner, a dependable funnel and a shape which insures a bevel of joint material outside the bell. In cold weather, bituminous compounds sometimes chill in the bell of the pipe and fail to fill it. The greater volume of material used in the Flex-Form tends to maintain temperature and fluidity until penetration is complete.

Contrast of Methods

In contrast with the foregoing methods, the hand-troweled joint depends for tightness upon the care with which cement is rammed into every portion of the bell. In a cramped position in dark trenches liability to faulty workmanship is great. There is further liability on the part of the troweled joint material to run or sag during setting. Even where troweled joints are constructed with greatest care it is almost a certainty that the cement will be disturbed by manipulation of the pipe in making the next joint.

In the poured joint, gravity insures penetration of the joint material to the farthest recesses of the bell. The Flex-Form safeguards against running or sagging. Disturbance is avoided by placing all the Flex-Forms for the job (or day's work) before pouring the first one. They are then poured in succession and left to set.

Further, it is proven that a comparatively thin grout makes a denser joint substance, when set, than the relatively stiff mortar used in the troweling process.

Joints in Vertical Pipe

In vertical pipe lines the bell end of the pipe is placed uppermost, the spigot of the next pipe inserted and caulked and the joint material poured into the bell, which retains it during setting, without the aid of a runner.

In joining horizontal lines of small diameter pipe with a bituminous compound, it is common to join the pipe in couples or threes by this method and leave them standing upright until the material is cold. The two or three sections are then treated as single sections of longer pipe and joined to each other in the trench with the aid of a Flex-Form or asbestos runner.

Very truly yours,

1672 Summit St., Columbus, O. DEWITT H. WYATT.

PLANT UNITS AND LAY OUTS

New Concrete Mixer Loader a Big Cost Cutter

The Koehring mixer loader is adapted for use either with the end loading paving mixers or with the side loading mixers used on general construction work. It increases mixer production and reduces to the minimum the owner's dependence on manual labor. It eliminates wheelbarrows entirely.

It can be used with any mixer without changes in the mixer except the placing of a baffle plate in open end loading skips, which is a simple job for any local mechanic. No baffle plate is required with closed end loading skip.

In paving work it precedes the mixer under its own power. In use with side-loading construction mixers it bridges the gap between materials and the mixer; thus the materials may be unloaded at the curb side, shoveled into the measuring bins of the loader and conveyed by the moving belt to the mixer at the base of an elevating tower, at the side, or on the inside of the building.

The use of the Koehring loader in the operation of a two-bag paving machine on street work shows the possible payroll saving. The loading crew usually consists of four wheelers for stone and two for sand—in other words, six wheelers per batch—and two sets of wheelers and one set additional shovelers are usually required to keep the mixer operating at top capacity. This means in all eighteen men. If, with the mixer loader, six men are retained for shoveling materials from subgrade into measuring bins of the loader, a total of twelve men or all the wheelers have been eliminated.

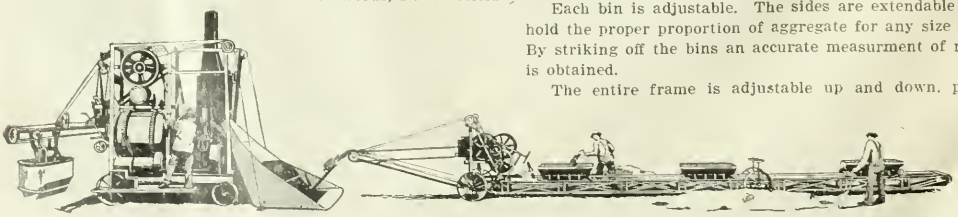
The mixer loader is a combination of measuring bins and the belt conveyor principle applied to a light portable machine, which is supplied with its own power and traction, moving from job to job under its own power and in paving work preceding the mixer. The full over-all length of the machine is approximately 60 ft. It receives materials from any point within this distance of the mixer. For shipping, half of the frame is quickly detachable.

The measuring bins are mounted on the frame and provided with wheels which roll on tracks on the top and along the length of the frame. According to the capacity of the mixer, two or three bins are provided.

As materials are shoveled from the subgrade, as in paving work, these bins are moved along the top of the frame to maintain them in convenient shoveling position to materials.

Each bin is adjustable. The sides are extendable so as to hold the proper proportion of aggregate for any size of batch. By striking off the bins an accurate measurment of materials is obtained.

The entire frame is adjustable up and down, providing



SKETCH OF THE NEW KOEHRING CONCRETE MIXER LOADER IN OPERATION.

plenty of clearance for traveling from job to job, and permitting the structure to be lowered to a point of small "lifts" in shoveling materials from the subgrade. The range of this adjustability is 10 in.

When bins are filled with aggregate, properly measured, a lever control opens the bottom of each bin, permitting aggregate to fall on the conveyor belt, moving at the speed of 500 ft. per minute, which carries materials to the mixer and into the loading skip, which is then operated in the usual way.

The speed of the conveyor belt necessitates the use either of the loading skip or a measuring batch hopper, because the high speed of the belt conveyor does not permit the new charge to be started toward the drum until the last batch has been completely discharged. This would cause a delay on each batch, and a delay on the part of the bin loaders. The mixer loading skip or batch hopper, however, is always ready to receive the aggregate from the belt conveyor, and the shovelers can instantly reload the measuring bins of the loader. In the meanwhile when the last batch has been two-thirds discharged from the drum, the loading skip has been started as is the usual practice, so that new aggregate enters the drum at the instant the last preceding batch is discharged.

Some Hints on Economical and Ornamental Street Lighting

By F. M. Jourdan, South Bend, Ind.

Conservation is a word heard repeatedly and it is well to consider some phases of its meaning. First, it is to take care of what we have, that its usefulness may be prolonged. Next, it is to be sure our methods bring the maximum results with the minimum expenditure of time, money, and labor. From the latter angle conservation may call for considerable outlay to supplant obsolete and inefficient apparatus with that which is modern and efficient, nevertheless, if by so doing, better results are obtained for less cost, not only is it good business practice, but it is conservation in the best sense of the term.

Inefficient Arc Lamps

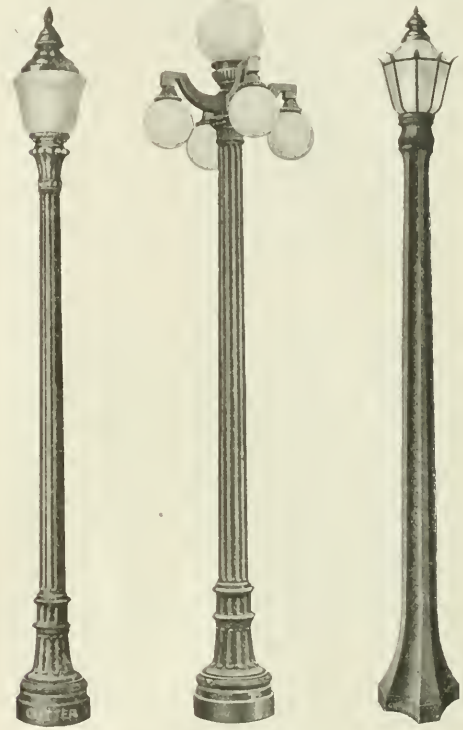
One fertile field in which this sort of conservation can profitably be employed is street lighting. Many places still use various types of arc lamps with their flickering light, which require constant attention and are increasingly expensive to maintain. To replace these lamps with pendant fixtures, using the highly efficient Mazda "C" lamps, institutes a saving which in some cases, is sufficient to pay for the cost of the change in less than a year. This means a smaller appropriation for maintenance for the years following, or permits an increase in the number of lighting units without adding to the sum formerly assigned to the arc lamps.

Advantages of Pendant Fixtures

Incandescent lamps being available in different candlepower sizes, it is possible to select a lamp that will give just the right amount of light and keep power consumption to a minimum. Pendants should be selected that have a provision for adjusting the position of the lamp socket, so that no matter what size of lamp is used, it can be placed at the proper point with respect to the reflector and diffusing globe. Pendants, if made of cast iron, galvanized and coated with an enamel paint, cannot be dented or forced out of shape in shipment or handling and the protective coatings prevent corrosion, so that if the paint is renewed occasionally they will last indefinitely. When used on series circuits, Mazda lamps should be held in cutout sockets so that when a lamp fails for any reason, the cutout will puncture and maintain the circuit, otherwise all lamps will remain out and difficulty will be experienced in locating the seat of trouble. The design of the socket should be such that only the proper film can be used, thus assuring the certain functioning of the cutout.

The Ornamental Post

One of the most modern methods of utilizing the advantages of Mazda lamps is the ornamental cast iron post, surmounted by artistic diffusing globes which are attractive by day as well as by night, combined with efficiency of illumination. Adequate lighting is a necessity; attractive lighting is a



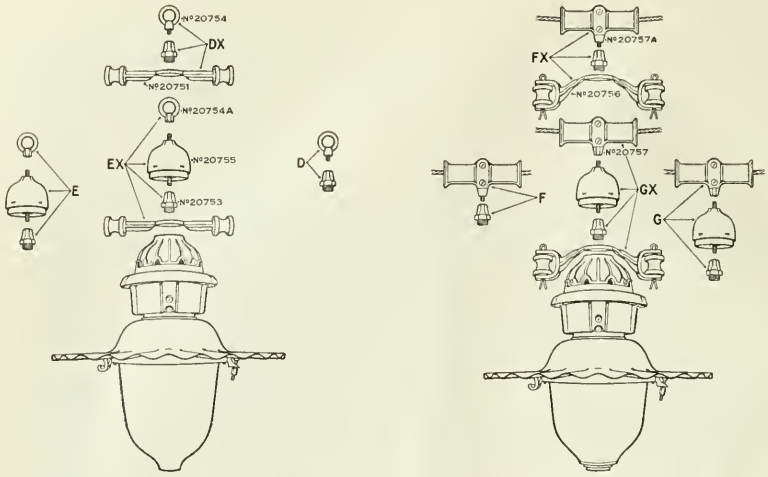
TYPES OF MODERN AND OBSOLETE STREET POST LIGHTS.

Left to Right: One-Light Broadway Post, a Modern Unit; Broadway Post With Cluster Top, Obsolete Type; One-Light Arcadia Post, Combining Simplicity and Efficiency.

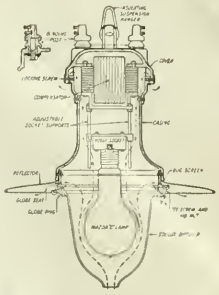
good advertisement for the community which supplies it; and post lighting combines both in one. The ornamental post with its cluster of lights, served its purpose in the days before the large gas-filled lamps were introduced, but at the present stage of the art, clusters are considered wasteful. The several small lamps are not as economical as one large lamp, either in wattage or maintenance of glassware. Considered from an illuminating standpoint, the cluster does not meet the standards set by the best engineering practice. In most cases it is possible to remove the cluster top from an ornamental post and replace it with a single unit fixture, thereby bringing the unit up-to-date at a small cost, in many instances the cost of the change will be saved in less than a year.

Lighting New Industrial Streets

The springing up of new plants to engage in the manufacture of war material, has in many instances necessitated the laying out of streets in their vicinity and the building of many houses to accommodate the employees. These new areas require lighting as much as do the older thoroughfares. Such cases usually call for a street lighting system that is flexible and easily installed. The Streethood is a fixture that fulfills the requirements for this work. Built up from interchangeable



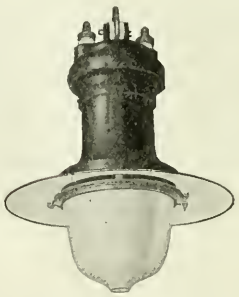
INTERCHANGEABLE PARTS FOR EIGHT STYLES OF CUTTER STREETHOODS.



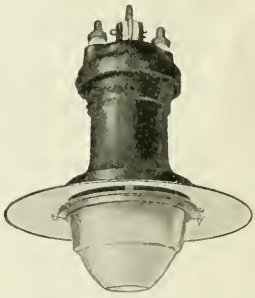
SECTIONAL VIEW OF CHICAGO TYPE PENDANT.

parts, it can be adapted for mounting on a bracket; hung from a mast arm; or suspended from a span wire. Fitted with either a multiple or a series socket and provided with a correctly designed porcelain enameled reflector, and either a diffusing globe or a refractor, most any condition influenced by spacing distances, mounting heights, circuit or intensity of illumination can be met. In parks and other seasonable resorts, in fact wherever a durable, inexpensive and efficient outdoor lighting fixture is needed, the Streethood admirably adapts itself to the requirement.

With the foregoing forms of lighting units from which to choose, any community can have well lighted highways and public places, and at the same time conserve the nation's resources. In fact, wherever the present lighting methods or equipment are obsolete, a change to modern units will conserve coal and labor, and the decreased operating and maintenance expense will save the cost of the new installation in a short time.



CHICAGO TYPE PENDANT WITH THE "SOL-LUX" DIFFUSER.



CHICAGO TYPE PENDANT WITH SKIRTED REFRACTOR.

GENERAL ARTICLES

Some Observations on a Common Practice in Sidewalk Construction

By Winfred D. Gerber, Civil and Sanitary Engineer, 913 Chamber of Commerce Bldg., Chicago

I think every specification I ever read on the construction of cement or concrete sidewalks had a clause, of more or less length, devoted to the *idea* that the walk should be constructed as a series of detached blocks or flags, the intent being to have the blocks so constructed that when the walk was ready for service each flag would be a unit within itself and any disturbance it might sustain would not be communicated to the adjacent flags.

Unit Blocks

My earliest recollections of sidewalk construction are of contractors who produced just these results by so arranging the sequence of their work that a flag was not laid until the adjacent one had set and paper partitions had been placed between flags at the joint. The two common methods of procedure were: (1) To begin at the center and work alternately at either end, and (2) to lay each alternate flag throughout the length of the job and when these had set for 24 hours or longer to lay the intermediate flags, strips of tarred building paper being placed in the joint between flags as an extra precaution against sticking.

The contractor of today is continually on the outlook for methods and appliances for increasing the efficiency and output of his organization and which at the same time will permit a reduction in the cost of manual labor. This is a perfectly natural development and one which is not open to criticism unless the desire for output outweighs the desire to do good work. On the other hand, to the average purchaser, "all walks look alike," and he proclaims, "He won't be held up by any bunch of sidewalk contractors," and proceeds to let his contract at the lowest figure. Naturally, the contractor,

not being a philanthropist, resorts to "methods" of construction in order to make good on the price.

Common Faults in Construction

The list of "methods" used in making good on a cheap price are so numerous that space does not permit reciting them, but a few of the most common may be cited, i. e., insufficient compacting of the foundation, any old material for foundation or filling, undersized form lumber, etc. These all have a certain amount of influence on the durability of the finished walk, but the point I wish to make is one of the "methods" frequently observed, of making these so-called separate flags. This usually consists in first marking off on the side rails the lengths of the flags; a cross rail *may* or *may not* (it's about 50-50 either way) be placed as a physical limit of the flag. Such a cross rail, however, has but little to do with actually defining the length of the flag, for the reason that about as soon as the base course has been placed and tamped it is removed and a new flag started without further ado. The finish coat is applied without regard to the limits of the flag and when it is ready to be finished a straight edge is placed across the walk at the marks on the side rails and with this as a guide the *surface* is neatly marked off in definitely defined rectangles by the use of a cutter, which only cuts down a short way, leaving the lower portion of adjacent flags in intimate contact, and when the cement has set they are practically as one piece. One has only to observe the cracking of a cement walk at other locations than these so-called joints to be convinced that it is not the weakest place in the walk. I recall a small city in Illinois, where the only limit the contractor had in laying a single length of walk was the length of the block. The surface was marked off to look like blocks, but as a matter of fact the walks were continuous for a block in length.

Again, I have never felt that a comparatively thin wet top coat laid on a rather dry base course was a desirable way to get a good walk. All too frequently the top checks off and leaves a poor looking, as well as rough-surfaced, walk, particularly if the walk is being laid during cool or frosty weather.

Suggested Improvements

Much improvement has been made in the construction of concrete pavements. Why not use some of this experience on sidewalk construction and make the entire thickness somewhat thicker than is now the practice, of one consistency and mixture, flushing enough mortar to the surface by proper compacting so that the required finish may be given to the surface. Make the slabs in lengths of approximately 20 ft. with a definite expansion joint ½ in. wide, filled with some type of asphaltic joint filler between each adjacent section. A mark or groove across the walk every 5 or 6 ft. adds nothing to the usefulness or durability of the walk unless it efficiently fulfills the function for which it was made; otherwise it is "camouflage."

Observation of walks that are kept well cleaned during the winter show indications of greater frost effect (heaving) than walks covered with snow all winter long, as the clean walk gave opportunity for the cold to penetrate more quickly the walk and freeze the damp foundation. Improvement in this particular may be obtained by lowering the level of ground saturation by installing a system of tile drainage and by placing a firm but porous foundation under the walk of sufficient thickness to prevent the formation of ice adjacent to the under side of the slab.

City Planning as an Engineering Problem

By Nelson P. Lewis, Chief Engineer, Board of Estimate and Apportionment, Municipal Building, City of New York

The subject of city planning has lately attracted much attention on the part of municipal officers and groups of public-spirited citizens, while it has been the subject of study and discussion by many whose interest appears to have been largely academic. Many of the writers upon city planning have been architects, landscape architects, students of municipal affairs and civic workers, and in not a few cases the authors appear to be somewhat superficial observers whose attitude has been severely critical and who have seldom found anything to commend in their own country.

Shortcomings of Some European City Planning

Up to within the last three years, most of them were enthusiastic in their praise of German efficiency in the planning, as well as in the administration, of their cities, which were almost invariably held up as the last word in city planning. German efficiency in administration will be quite generally acknowledged, notwithstanding the fact that behind that efficiency we have lately seen a brutality rarely matched in the history of the world. In German planning, the chief emphasis appears to have been placed upon the impression to be produced upon the visitor. Dr. Werner Hegeman, of Berlin, has himself pointed out that in the remodeling of some of the European cities, only beauty and elegance were sought and that

> "to the production of this metropolitan elegance, the most refined thought was given, but this thought benefited mainly the central sections of these capitals (the parts near the castles) and the exterior facades of the tenement houses. Behind these good-looking facades, miserable crowding, lack of house gardens and the choking of the next generation were permitted. This kind of city planning did not attempt to make comprehensive, preconceived plans covering all branches of city growth, but touching only one or two aspects (mainly artistic), exaggerated their importance and did nearly as much harm as no planning at all."

Conditions Producing Tenement Houses

The same authority, in an equally frank criticism of the conditions existing in Berlin and Charlottenburg and an attempt to put his finger on the reason, has noted that this metropolitan district, with hundreds of thousands of families in one-room houses,

> "is suffering from too wide, too well paved and too highly organized roads, and from the extensive high tenement houses that seem necessarily to result from too expensive roads carried into purely dwelling house districts."

Correcting Mistakes Due to Lack of Plan

The American literature on this subject abounds in illustrations of foreign cities with views showing the grouping of public buildings and picturesque "plazas," many of which there has been a disposition to transplant to this country, however inappropriate they may be to the topography and to the traditions of the people. Too little attention has been given to the structural plan of the city, and yet it is this very structural plan which may make a city convenient, orderly, and even beautiful, and which will avoid the necessity of extensive changes at immense cost. Such changes, involving sometimes complete reconstruction of certain districts, have been undertaken by American and foreign cities, and they have probably been well worth while. These projects are commonly called city planning, but they actually amount to little more than the correction of mistakes, due to lack of a proper plan.

An Engineer's Definition of City Planning

City planning has been variously defined by those who are disposed to emphasize its architectural, its social or its economic aspects. The writer's definition, frequently used by him, is this:

> "City planning is simply the exercise of such foresight as will promote the orderly and sightly development of a city and its environs along rational lines, with due regard for health, amenity and convenience and for its commercial and industrial advancement."

This definition may be recognized as that of the engineer, rather than of the artist, the economist or the social worker, and yet, while it lays stress upon the practical aspects of the problem, it does not ignore the ideal.

If it be admitted that the need of planning is fundamental and that the plan should exist from the beginning and should direct and control the growth and development of the city, it must be admitted that the engineer must play a very prominent part in the development of the plan, and it must also be frankly admitted that the failure on the part of the engineer, who is almost invariably the first man on the ground, to realize the importance of the preliminary work done by him and its controlling influence upon the future of the city, has been the excuse for, if not the contributing cause of, the expenditure of vast sums for reconstruction or for the correction of mistakes.

Conspicuous Elements of Proper Plan

Bearing in mind, then, the definition of city planning which has been given, the conspicuous elements of a proper plan will be briefly outlined, and first among these elements the writer will place the unromantic but vitally important matter of the transportation system, or the means provided for getting in and out of the city and for the quick movement of passengers and freight from one part of the town to another. It is obvious that transit needs cannot be accurately foreseen, but provision should be made for improving them and extending them when needed. A large part of the transportation will always be in the streets themselves, and its adequacy and efficiency will be largely determined by the location and dimensions of the streets in which the interurban transit lines are located.

Street System

This brings us to the second important element, namely, the street system in which and through which the daily business is done, and by which the people gain access to their homes and pass from these homes to their work, their recreation and their amusement. The street system, once adopted and developed, must remain indefinitely. Some streets may be widened and an occasional new street may be cut through existing improvements, but the general street plan, once established and constructed, is fastened upon the city as long as the city itself lasts. It occasionally happens that a catastrophe, such as the great fire of London in 1866, or the San Francisco earthquake and fire in 1906, may afford an opportunity for recasting the plan of a considerable area, but in the feverish desire to make a new start and lose as little time as possible, such opportunities are rarely embraced.

Open Spaces

But a city is not merely a place in which business is conducted and in which the inhabitants work, eat and sleep. Provision must be made for recreation and wholesome amusement; public health must also be promoted by the introduction of sufficient open spaces, which actually serve as the lungs of the city. Parks and playgrounds are essential to the well being of an urban population, and no city plan will be complete which does not make provision for them. It is true that a lack of public parks may be supplied at any time, even when the space to be devoted to that purpose shall have been built upon, and when the cost of their acquisition will be greatly enhanced, but a park system can be most economically and satisfactorily established in advance of other improvements and facility of access to it and proper connections between the different park units will depend upon the street system, so that it is desirable that park plan be worked out in connection with the street plan.

Public Buildings

It must be remembered also that a city is a corporation conducting extensive business enterprises and suitable buildings must be provided for the purpose. The location of such buildings may render the conduct of public business convenient or difficult, and may give a favorable or unfavorable impression to visitors. Public buildings, like other business buildings, can be changed in location as necessity and convenience require, but the suitability of their sites, whether they are convenient and commanding, or awkward and unprepossessive, will depend upon the streets about them and leading to them, so that the location of these streets should receive most careful study in the preparation of the general plan of the city.

Sane Financing

But good city planning, even in its engineering aspects, involves more than the elements just enumerated. It includes plans for the sane financing of various public improvements in order that the burden of cost shall be distributed as equitably as possible, that the few are not enriched at the expense of the many, and that the city's credit shall not be recklessly used. It includes a study of the traffic problems of the town, not only provision for traffic in the working out of the street plan, but its regulation, in order that the existing street facilities may be used to their fullest capacity, avoiding in many cases costly changes which may be deemed necessary to accommodate unregulated traffic when, by the introduction of better system and control, the desired results can be secured by ordinance, instead of by bond issues or assessments.

Development of Private Property

The framework of a city may be intelligently planned, and yet the objects sought may fail of realization owing to the lack of such control over the development of private property as will insure health, amenity and convenience. Healthy living may be rendered impossible by over-intensive development, failure to provide sufficient light and air through the absence of adequate courts and back yards, and the lack of restrictions as to the height to which buildings may be erected. Amenity, or pleasantness of surroundings, requires good design of the streets and their details—not the introduction of fountains and statues and other highly decorative features, but good proportion and the obvious adaptability of means to ends, the repression of garish and obtrusive signs and hideous noises. The convenience and comfort of those using the streets are sacrificed if private owners are permitted to encumber the sidewalks by projecting portions of buildings or by temporary occupation for the display of goods, while street capacity, which might be ample if the abutting buildings were of moderate height, may be seriously congested if buildings are allowed to be carried to any height which the owners may find profitable.

The Environs of the City

Careful study may be given to and skill shown in the orderly planning of portions of a city, or even of the entire area within the city limits, and yet, when the boundary line between the city and the adjacent towns is passed, the roads may be of inadequate capacity or without proper articulation; the approaches to the city may be shabby and uninteresting and the only available roads leading to the neighboring towns may be tortuous in their course and may pass through the meanest parts of both, giving the traveler a very unfavorable impression. The environs of the city should, therefore, be studied in connection with and in relation to the plan of the city itself.

Semi-Public Buildings

While the original ground plan has chiefly to do with the street system, the provision of suitable sites for public and semi-public buildings should be kept in mind. While the precise location of such buildings cannot be designated far in advance, the general plan should be such that a special site need not be created for each building as the time comes for its erection, streets being widened and new streets cut through in order to provide access to it or to enable it to be seen to advantage. If, for the sake of public convenience and

in order to secure a good architectural effect, the important public buildings can be so grouped as to create a civic center, it should not be necessary to recast the street plan in order to do so. Not only for the buildings which are erected by the city and used for its public business should suitable sites be provided, but those of a semi-public character, such as railway stations, private educational institutions, churches, places of amusement and others, will, if properly designed and advantageously located, add character and distinction to the city and are entitled to consideration in the preparation of the original plan.

Prudent Land Policy

Certain parts of the city will be peculiarly adapted to specific uses, depending upon the topography, accessibility to transportation lines and other considerations. There will be business districts, industrial districts, high-class residential districts, and those where workmen can find cheap homes or low rents convenient to the places where they are to be employed. Special developments on the lines of the so-called garden cities, either for the accommodation of those employed in the business districts or in connection with industrial plants, will be undertaken if there are places available for them, and, in order that this may be possible without going miles beyond the city's limits, considerable areas can well be left undivided in order that such developers may have a rather free hand in carrying out such plans, provided always that there is a competent authority with full power to control the general plan and whose approval should be required before it can be carried out. American cities generally have little power of initiative. Legislative action is commonly required to permit them to do constructive work themselves or to enable them properly to control improvements undertaken by private individuals or corporations. Laws permitting them to do, to allow others to do, or to forbid others from doing, seem therefore to be necessary, and the framing of wise laws to this end is an important part of a city planning program. European cities are often large landowners and frequently indulge in land speculation, from the profits of which many of their social activities are financed. The adoption of and consistent adherence to a wise and prudent land policy is therefore necessary. Frequent changes of administration and reversal of policies have made state legislative bodies reluctant to give much power of self-government to American cities and public opinion appears to incline to this view. Intelligent city planning and the orderly execution of a plan depend to so large a degree upon municipal prudence and self-restraint and upon continuity of policy and purpose that municipal officers will have to show that they are capable of exercising such restraint and of working out and adhering to wise and prudent, even though they may be progressive, policies before they will be given that degree of self-government, the need of which is so obvious at the present time.

Did space permit, more emphasis might be placed upon the four primary elements of city planning, which have been pointed out as fundamentals. The importance of the first preliminary surveys should be insisted upon, which surveys will aid in the determination of the best location for trunk line railroads and terminals, so that they may be properly coordinated; a determination of the lines of main drainage, the best routes for arterial highways, the location of unimproved tracts peculiarly suited to park purposes, etc.

In connection with the street system, it should be pointed out that there should be a definite paving plan, as well as a street plan, the pavement in each case being selected with due regard for the grades, the amount and character of the traffic and the actual or probable use of the abutting property, keeping in mind also the need of continuous low-grade routes, with non-slippery pavement, by which all parts of the city may be reached under the most adverse weather conditions.

The Engineer's Responsibility and Opportunity

Attention should also be called to city management as an attractive field of activity for the municipal engineer. In this capacity, the handicaps due to defects in the city plan will be brought home to him very forcefully, and he will appreciate more fully the defects of a plan which are due in no small degree to lack of imagination and foresight on the part of the engineers who laid the foundations upon which the city has been built. The engineer does not yet appear to appreciate fully his responsibility for starting our cities in the right way. An engineer of one of the cities of Belgium has said:

"Engineers appear to take little interest in the subject, and if their apparent indifference continues much longer, they will find that this natural branch of their profession will pass into other hands, which would be much to be regretted."

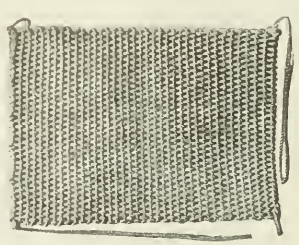
There are others ready and anxious to do this work, and if the engineer allows his natural title to the job to go by default, he will have no one to blame but himself.

Methods Employed and Precautions Observed in Blasting in City Streets

L. B. Steele, of E. I. du Pont de Nemours & Co., Wilmington, Del.

Blasting in city streets has been a problem to contractors and municipal engineers in the past due to the fact that, although all recognized the tremendous power of blasting powder as a time-saver, yet the possibility of accident prevented many from making use of explosives in sewer or subway excavation, except at rare intervals.

The war with its demand on the man power of the nation has cut down the supply of labor on which contractors have depended for the work in city street excavating and as a result of this shortage of available men, many engineers and contractors are at this time considering the use of blasting powder



BLASTING MAT USED IN BLASTING IN CITY STREETS.

in this type of excavation. They are studying the characteristics of this giant laborer with a view to adapting it to their needs.

The Two Essentials

The two essentials to be kept paramount in the use of explosives in city street work are: Care in handling and use of proper amount of blasting powder. If the contractor or engineer wishes to obtain the best results from the blasting method, he must have an intimate knowledge of these essentials before proceeding with the work. A failure to do so may result in the loss of life, damage to adjacent property and failure to accomplish the desired result.

The care used in handling the blasting powder should never be lessened from the time the explosive is bought until the blast has been made. The workmen must be informed that they must take the necessary precautions to insure safety and the foreman on the job must see that these safety instructions are followed explicitly. Some of the chief requirements are:

Chief Requirements for Safety

The blasting powder should not be kept in a wet or damp place, but should he stored in a dry place, under lock and key.

The workmen moving the kegs of blasting powder should avoid rough handling and care should be exercised in regard to smoking in the vicinity of the stores of blasting powder.

Probably the greatest caution must be taken when the blast is fired as the possibility of a person being in the locality should be prevented. All residents on the street should be notified to stay indoors. The square in which the area to be blasted occurs should be guarded at both ends and all workmen should get behind some sheltering object just before the blast is fired.

The Approved Method

In order that the most desirable results should be obtained, blasters should use the prescribed methods for work in city streets. Wide experience in excavating has shown that the following method is most satisfactory. A dependable, uniform blasting powder should be used, such as the red cross grade, and small charges should be used at each blast. This prevents danger of particles of rock and dirt being thrown great distances and also eliminates the possibility of breaking windows in the vicinity due to the concussion.

It is a wise policy to make a series of shallow blasts rather than one deep blast as the results will be more desirable when the series is used. Another step in obtaining a successful street blast is the use of the electric firing method instead of fuses as this insures complete control of the time of explosion.

Use of Blasting Mat

Most municipal contractors, who are doing any blasting in streets, are, in addition to the following precautions, using a "blasting mat" over the bore hole. This is a closely woven mat of hemp or wire rope that is used to catch flying material. The mats are made from 1 to 1½-in. rope and in rectangular shape. If the blast is light, the mat may he spread on the ground over the bore holes. If a heavier charge is used, railroad ties or logs should be put down and the mat placed on top of them. A view of the blasting mat is shown herewith.

If the contractor uses the foregoing methods and takes the required preventive measures all kinds of trench and subway work can be done by blasting in quicker time, at less expense and as safely as when blasting powder is not used.

How Engineering Records of Underground Structures Are Kept in Baltimore

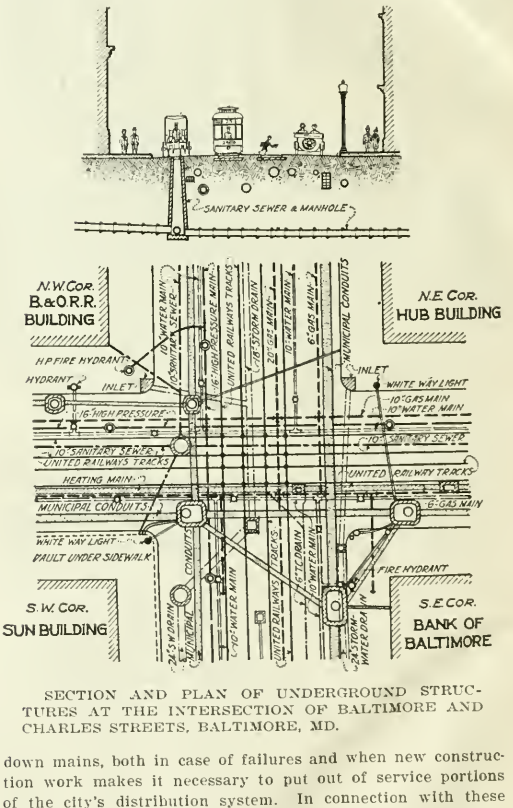
By M. J. Ruark, Chief of the Bureau of Drafting, Baltimore, Md.

The location of constructions which are above ground is comparatively simple. To keep an accurate record of underground instalations is quite another matter. Yet the city of Baltimore has in its possession, in plat form, with specific data as to location (depth and distance from the building line), a complete and up-to-date record of every live underground construction in the city, and of many obsolete private sewers and abandoned pipings. When the water department or the electrical commission sends out a force of men to do repair work they are not only furnished with complete data as to location of the particular construction they are to uncover, but are given the positions of all other installations which are to be found at that point, in order that they may not damage them during their operations.

The preparation and safekeeping of the innumerable plats which such a comprehensive system entails is in the hands of the bureau of drafting. Since the latter part of 1915 all the drafting forces of the city, with the exception of the building inspector's department, have been working as a separate and distinct department.

Water Department

The water department construction work is plotted in colors on mounted paper plats, about 28x28 in., to a scale of 1 in. equals 100 ft.; four of these sheets assembled together making a square of one mile. These plats show the reservoirs, pumping stations, main distribution pipes, services, valves, fire hydrants and other appurtenances, and are kept in a large case, the plats being hinged in a vertical position from which they can be moved or be replaced without difficulty. This method is very handy for quick reference. At this time we contemplate preparing record plans, on tracing cloth, on a scale of 1 in. equals 40 ft., about 24 ins. by 36 ins. in size. These plans will be traced from similar plats prepared in connection with the sewer work (described hereinafter) and will show, not only the size of all mains, services and appurtenances, but also the exact location, depth, etc., and it will then be possible to secure from these blue-prints, on paper or linen, which may be utilized by the construction forces either in the field or sub-offices. It is also expected that these plans will be used by the construction division in shutting



SECTION AND PLAN OF UNDERGROUND STRUCTURES AT THE INTERSECTION OF BALTIMORE AND CHARLES STREETS, BALTIMORE, MD.

down mains, both in case of failures and when new construction work makes it necessary to put out of service portions of the city's distribution system. In connection with these plans there will also be adopted a card system for keeping a complete record hereafter of each and every service installed. This scheme will shortly be put in final shape.

Electrical Commission

The city of Baltimore was the first city to establish a system of municipally owned and operated electrical conduits, to be leased to the telephone, telegraph and other public service corporations, on a duct rental basis. This improvement was started about eighteen years ago and is still in the course of extension. A very complete and detailed record of the construction has been kept since its beginning. Plans showing the work to be installed are now prepared on a scale of 1 in.

equals 40 ft. from which blue and white prints, for field use, are made. The engineering field force or inspectors record on these white prints any modifications or changes which may be ordered by the engineers in charge of construction, or which may become necessary owing to sub-surface constructions. These changes, as well as the actual measurements with complete details, are forwarded to the drafting room and are plotted on mounted paper plats about 26 by 36 ins., on the scale of 1 in. equals 20 ft. This drafting work is executed by draftsmen specially trained and skilled in such drafting and is the best record of this character, to my knowledge. Drawings of each cable manhole or box are also made to a scale of ½ in. equals 1 ft., for the cable inspection department, in order that a complete record may be available showing each electrical cable installed by public service corporations and which duct is occupied.

One of the first problems of the engineers engaged on the installation of the sanitary sewerage system was the preparation of a complete sectional map of the city to a scale of 1 in. equals 40 ft., showing the size, location and depth of all subsurface structures installed up until that time. These data were collected from numerous sources and some of them were therefore more or less unreliable.

A careful record was, of course, kept of all sewers, house connections and all drains installed and practically all of this work has been plotted and the records are available for ready use.

Construction notes and data in connection with this work were kept in surveyors' field books, as is the usual practice amongst engineers in general.

Gas Mains

The Gas Company (The Consolidated Gas, Electric Light and Power Company) keeps its own records and, by experience, this corporation has found it to their advantage and also economical in the long run, to take particular pains that a complete and careful record is kept of all their work. In fact they go into a good deal of detail and even locate each and every joint in the pipe lines in order that they may more readily locate leaks which later occur. They are thereby able to repair such leaks with the least amount of disturbance to the improved paving.

In order that the reader may obtain some idea of the costly and complicated system of underground mains and conduits and of the functions of the Bureau of Drafting in this connection, the accompanying illustrations have been prepared showing the intricate network of underground mains and conduits, at the intersection of Charles and Baltimore streets.

Prior to the activities of the Paving Commission it is the practice of all municipal departments to renew and rearrange these mains and conduits in a manner sufficient for future as well as present demands, but even with this forethought and caution it sometimes becomes necessary to tear up recently improved thoroughfares. For instance, water mains will freeze during severe weather, sewers and drains will become choked (usually through the carelessness of the property owner), and many other emergencies will arise which will necessitate the tearing up of new paving. To avoid this tunneling is quite often resorted to, it being a well-established fact that the pavement once cut into can be restored to its original condition only with difficulty, if at all. The average pedestrian is quite unaware that such repairs are being made under the street without any inconvenience to him or the closing of the street to ordinary vehicle or street railway traffic.

Not only does the keeping of these records save considerable expense in making repairs and installing additional structures when required, but a considerable saving of time is also accomplished and the inconvenience caused to the public materially lessened.

The intersection of Baltimore and Charles streets has been selected in this case as representing only the average conditions.

CATALOG REVIEWS

ONE-TON TRUCKS—Issued by Maxwell Motor Co., Inc., Detroit, Mich. 6x8 in.—16 pages. Illustrates Maxwell 1-ton trucks and explains field of their usefulness. Shows some major features of design and gives chassis specifications, body dimensions and price list.

SEWER INLETS—Issued by the Burch Plow Works Co., Crestline, Ohio. 6x9 in.—30 pages. Relates especially to the Burch Sewer Inlets, which are illustrated and described in detail. A large variety of designs shown. Catalog also features manhole covers, rooter plows, steel road plows, cast iron culvert pipe and bulkheads for pipe. Other Burch literature illustrates and describes the Burch stone spreader and distributor and the Burch stone unloader.

LAND DREDGES—Issued by the Bay City Dredge Works, Bay City, Mich. 6½x10¼ in.—30 pages. Shows Bay City land dredges in operation on a large number of interesting jobs. Contains many testimonial letters, giving operating data.

ROAD MAKING, ROCK CRUSHING AND EARTH HANDLING EQUIPMENT—General catalog No. 18, issued by the Austin-Western Road Machinery Co. 9x12 ins.; 48 pages. Illustrates, describes and shows the field of application of the lines of road making, rock crushing and earth handling equipment manufactured by this company. Especially features reversible road machines, graders, road rippers, the Austin Ripsnorter, Road Planer and Finisher, portable rock crushers, stone elevators, screens and bins, motor rollers, dump cars, scarifiers, elevating graders, dump wagons, street sweepers, street sprinklers, pressure road oilers, road drags, wheeled scrapers, drag scrapers and road plows.

HOISTING BUCKETS AND TUBS—Catalog E, issued by the Brown Hoisting Machinery Co., Cleveland, O. 6x9 ins.; 64 pages. Illustrates and describes the Brown line of buckets and tubs used in hoisting and conveying loose materials.

BUILDING MATERIALS—Issued by the Philip Carey Co., Lockland, Cincinnati, O. A pamphlet illustrating and describing the Carey line of building materials, with special reference to roofing shingles, cement roofing, rubber roofing, ceil board for walls and ceilings, insulating paper, asphalt saturated felt and asphalt paints.

CONCRETE MIXER—Folder issued by the Blaw-Knox Co., Pittsburgh, Pa., featuring the Blaw-Ransomixer.

PERMANENT CONCRETE ROADS—Issued by the Truscon Steel Co., Youngstown, O. 5½x7½ ins.; 128 pages. Contains a history of concrete pavements and chapters on the concrete roads in Wayne county, Michigan, maintenance of concrete roads, etc., and shows the use in concrete road and pavement construction of Kahn reinforcing mesh, armor plates, curb bars, edge protectors, etc. Contains many good illustrations of concrete road construction operations.

CONSTRUCTION MACHINERY—Issued by Lakewood Engineering Co., Cleveland, O., as a general catalog. 6x9 ins.; 162 pages. Illustrates and describes concrete mixers, charging hoppers, steel hoisting cars, concrete chutes, clam shell buckets, miscellaneous buckets, contractors' cars, and a selected number of typical Lakewood installations which are illustrated and briefly described.

HOW TO MAKE AND HOW TO USE CONCRETE—Issued by the Ransome Concrete Machinery Co., 115 Broadway, New York City. 5x7½ ins.; 152 pages. Price, $1.00. The Ransome

line of machinery and concreting equipment is subordinated to those fundamental facts which make for success in the use of concrete. Written and compiled by H. Colin Campbell, C. E., director editorial bureau, Portland Cement Association.

Trade Notes

With the completion of the greatly increased facilities now planned, the Service Motor Truck Company, of Wabash, Ind., will have one of the largest and most modern truck factories in the country. The actual enlargement of the plant is now under way, and still further enlargement is planned when units now under way are completed. During a recent week domestic orders totaling more than a half million dollars were received. Contracts were recently let for the construction of two new buildings. They are of steel and brick construction and are now nearing completion. One is 50 by 450 ft. and the other is 75 by 200 ft. When they were planned last fall, their construction was considered adequate to care for the growth of the business for some time to come. The unexpected expansion of the trade, due more or less to freight congestion and the demand for trucks for intercity hauling, has shown in even that short a time that a still further increase of facilities is needed immediately.

When the units now under construction are completed the Service plant will have a capacity of twenty trucks a day. With the further additions soon to be started, the capacity will be more than doubled to allow for fifty trucks a day.

Forrest J. Alvin, general manager of the United States Motor Truck Company of Cincinnati, has completed arrangements with C. W. Moody of New York, A. W. Wyckoff of Pittsburgh and J. W. Boyd of Akron whereby these men will act as wholesale distributors for United States trucks in the New England states, Maryland, Pennsylvania, Virginia, North and South Carolina, New York and the eastern portion of Ohio.

J. F. Bowman, vice-president and general manager of the Acason Motor Truck Company of Detroit, is strongly in favor of a movement to bring about the loading of all trucks with merchandise when these trucks are being delivered by roads to dealers and distributors throughout America. Mr. Bowman believes that in this way much good will be done in relieving the freight congestion and in saving waste energy which comes about through driving the trucks through the country without load. There are being established in many parts of America what are known as reload bureaus and these organizations will gather together vast amounts of merchandise which may very easily be taken to destination by trucks which ordinarily would travel empty. Expenses of delivery of trucks would in this way be brought to a very low point, thus saving in the freight situation and also in the expenses of delivery.

H. T. Melhuish, a brother of William Fulton Melhuish, Jr., president of the Fulton Motor Truck Company of Farmingdale, L. I., has succeeded E. E. Vreeland as advertising manager of the company. Mr. Vreeland, who remains a stockholder in the Fulton company, recently became an officer of the Abbot & Downing company, at Concord, N. H. Mr. Vreeland is head of the Vreeland advertising agency of New York.

Finding the former name inadequate to cover its wider field of activity, the Trussed Concrete Steel Co. has changed its name to the Truscon Steel Co. In its early days, years ago, this company devoted itself exclusively to reinforced concrete, introducing many new reinforcing products, such as the Kahn bar, Floretyles, etc. For many years, however, the activities of this organization have expanded far beyond the concrete field, so as to include a large variety of steel products. Prominent among these might be mentioned the steel windows so widely used in building work, metal lath, pressed steel joists, all-steel buildings, inserts and other specialties. Fortunately, in selecting a name embracing all its present activities, this company can readily follow the trend of popular suggestion. For years the company has been generally known by the name "Truscon"—a simplified abbreviation of the longer name. For this reason "Truscon Steel Co." has been selected as the new name of the company. Aside from this simplification of the name of the Truscon Steel Co., there has been absolutely no change in the company, its organization or management in any way. Representatives, locations and everything about the company are identically the same. The new name is the Truscon Steel Company, with plant and general sales offices at Youngstown, Ohio, and representatives in principal cities.

Personal Items

M. E. Kelley, formerly assistant city engineer of Anaconda, Mont., has been appointed city engineer to succeed W. B. Vestal, Jr., who resigned to take a position in Spokane, Wash.

John S. Lewis, who for nine years was superintendent of water works at Youngstown, O., has resigned that position.

Dudley Chipley, engineer and superintendent of the municipally owned water works at Columbus, Ga., has also been appointed county engineer.

Fred G. Whaley, who for several years was city engineer of Chehalis, Wash., is now with the Washington State Bureau of Inspection, in the Department of Appraisal for Municipal Utilities, with headquarters at Tacoma, Wash.

Randolph Martin has been appointed county engineer of Ontonagon county, Michigan. He formerly occupied a similar position in Houghton county, Michigan.

H. L. Sweet has been elected city engineer of Okmulgee, Okla.

H. A. Perkins has resigned the office of city engineer of Leavenworth, Kans., which he had held for four years.

R. L. Sizer has been appointed city engineer of Cumberland, Md.

E. F. Johnson has been appointed city engineer of Virginia, Minn.

James E. Mast has been appointed civil engineer in the Bureau of Water of the city of Reading, Pa., to succeed J. Fred Whitman, who resigned.

H. Hilliard has been elected city engineer of Oldtown, Me.

J. N. Mackall, office engineer of the Pennsylvania State Highway Department, resigned that office on April 15 to accept his appointment by Governor Harrington as chief engineer of the Maryland State Roads Commission. Mr. Mackall was appointed office engineer of the Pennsylvania State Highway Department by former Commissioner F. E. Black. He graduated from Maryland State College in 1905, and immediately thereafter entered the service of the Maryland Geological Survey, where he remained until 1908, when he became connected with the Maryland State Roads Commission, which was organized at that time. He served continuously with the Maryland State Roads Commission up to March, 1917, when, on the recommendation of Chief Engineer W. D. Uhler, of the Pennsylvania State Highway Department, he was appointed office engineer. His engineering ability is indicated in many up-to-date methods which he introduced during his short term of service with the Pennsylvania Highway Department.